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The Society of Arts' Prize. A CABLE dispatch announces that the prize of the Society of Arts has been awarded to Thomas A. Edison. It is a pleasure to see in this the acknowledgment on the part of English scientists of the valuable services rendered by an American, who in the early days of electric lighting did more than any one else to make incandescent lighting a success, both from an engineering standpoint and from a commercial one. This prize was founded in memory of the Prince Consort, and consists of a medal. Among those who have received this prize are Faraday, De Lesseps and many others of like fame.

American Electric Goods Abroad. IT is often claimed that American manufacturers of electrical apparatus cannot send their goods into European markets and compete with the manufacturers in those countries on account of the greater cost of labor here and the greater purchasing power of money abroad. An interesting illustration, showing that this is not always the case, has just come to our knowledge. A well known American manufacturer of a certain class of electrical apparatus which, within a very few years, we imported almost exclusively from abroad, exhibited his goods at the Frankfort electrical exhibition last year, and, notwithstanding the prejudice which existed against American goods of this class, and the fact that, owing to their high grade, they were high priced, the goods were greatly appreciated by the foreigners, and the sales within the few months after the closing of this exhibition amounted to a large sum, which is daily and rapidly increasing. It is a pleasure to see that these goods, which foreigners have repeatedly claimed Americans would never be able to make, have gained such a well deserved recognition abroad.

Condensers in Alternating Current Distribution. ALTHOUGH the application of condensers in alternating current systems has not yet been made an accomplished fact in practice, yet the possibilities and advantages make this a subject of considerable interest at the present time, even though it may be quite a while before actual work is done in this direction. Swinburne, Stanley and others are working hard in this field, and it is not unlikely that they will arrive at some very useful results sooner or later. As the behavior of condensers in alternating current circuits is, perhaps, not well understood by many, we publish in another column a short but clear summary of the subject, which, without considering the whys and wherefores, shows the different ways in which condensers may be connected, and how they will act when thus introduced into branch or main circuits. It will doubtless be difficult for many to understand the apparently curious fact that a condenser in circuit may raise the potential far above that used to charge it. It acts in this case similarly to a transformer, changing volts into ampères and ampères into volts, so to speak, or more correctly, changing the quality of the energy. As the condenser may in future play an important part in alternating current work, a clear understanding of the underlying principles will help one greatly in dealing with the problems which must come up.

High Speed Electric Express. AS WE go to press the announcement is made that Dr. Wellington Adams has made an appointment with the New York Electric Club to give an illustrated lecture upon the project with which he is connected of building and operating an electric railway between St. Louis and Chicago, upon which through trains will make the trip of approximately 250 miles in two and a half hours. The scheme proposed by Dr. Adams is not a new one to our readers. A map of the route over which the route is to run and description and illustration of the proposed car were published in THE ELECTRICAL WORLD of Feb. 20, 1892. It is now announced that the entire line has been surveyed, the right of way secured for fully 60 per cent. of the property over which the line passes, terminal facilities obtained in both cities and sites purchased for both of the power houses. Only two generating stations will be employed, and these will be located at points midway between the centre and ends of the line, one being at the mouth of a coal pit and the other in close proximity to an abundant supply of water power. Should the plans of Dr. Adams succeed—and who is bold enough to predict a failure for such a magnificent enterprise, whether viewed from an engineering or other standpoint—the tremendous impetus it will give to electrical projects of a similar nature can only be imagined. No enterprise now on foot in any part of the world so fully deserves the attention of electrical engineers as this experimental line for the transportation of passengers at a speed greater than that of the Empire State express, now the fastest long distance train service in the country.

Electricity and Caterpillars. A PARAGRAPH has been circulating through several dozen daily papers during the past six months describing, in language which is amusing rather than instructive, a method recently suggested by an electrician for preventing caterpillars from crawling up trees, by means of a simple electrical device. As usual with such items that travel the rounds of our daily papers, the facts of the case have been greatly distorted, making the suggestion appear absurd, while as a matter of fact it is based on quite rational principles. For the benefit of those interested we give here a correct description of the original suggestion. A simple method used many years ago by naturalists, to imprison small, crawling animals for examination, without having to cover them, was to place them on a silver coin, surrounded by a circle of copper wire, the whole being placed on a piece of moist paper, the two metals and the moist paper forming a galvanic cell. When the animal attempts to crawl away from the coin it comes in contact with the copper wire, whereby it short circuits the battery, and receives a shock which causes it to retreat, thus confining it to the coin. To apply this same principle to prevent caterpillars from crawling up trees, it was suggested to run a copper and a zinc wire (galvanized iron wire would probably also answer in place of the zinc) around the trunk of the tree about half or a quarter of an inch apart. But an essential feature, omitted in all the newspaper paragraphs, is to place underneath the wires a piece of blotting paper or cloth moistened with salt water. In crawling up the trees the caterpillars must cross both wires at once, which will probably give them a sufficiently powerful shock to make them prefer some other tree. A paper moistened with salt water will keep moist except in very dry weather. When the caterpillars become sufficiently well educated in electrotechnics they will crawl over these wires obliquely, so as not to touch both at once, and will then be rewarded by having the whole tree for themselves.

Efficiency of Transformers. IN the article of Mr. Dobrowolsky on transformer efficiency, of which we publish the conclusion this week, the author points out some very interesting deductions which cannot fail to be of use to transformer builders. He shows the advantages of making quite a radical change in the principles formerly held for transformer construction. The new principles which he advocates are in some respects quite opposite to those formerly accepted as the best. For instance, it has usually been held that the copper coils should be inclosed as much as possible with iron in order to save copper; he now shows that the iron should be inclosed as much as possible with copper in order to save iron, that is, of course, to diminish the iron losses. Magnetic joints were generally considered objectionable, but he now shows that they may even be made useful to balance the effect of the static capacity of the line. Stress was formerly laid on diminishing the magnetic reluctance as much as possible; this he states is not as important as other features which influence this reluctance. With direct current distribution it was found long ago to be cheaper in the end not to attempt to have self-regulation by having the losses small, but rather to increase them somewhat and then regulate the voltage; so with transformers, he recommends making the losses greater and then to use some regulating devices. He comes to the conclusions, which are in some respects similar to those to which Swinburne was led, by taking into account, as Swinburne did, the all-day efficiency of transformers; that is, by considering the fact that during the greater part of the day the transformer is working with a small load far below its normal output. It is, therefore, necessary to consider more particularly the losses for small loads rather than for the maximum output. This is accomplished not by making the transformer smaller, and letting it be overworked slightly on full load, but by modifying the construction so as to make the constant losses smaller at the expense of proportionately greater losses for full load. As Mr. Dobrowolsky is known to be clear-headed and unbiased in his views, intent merely on getting at the best results, his opinions and deductions are well worth considering.

Queer Sources of Testimony on Underground Rapid Transit. ACCORDING to recent reports the Rapid Transit Commission of the Supreme Court has just had to listen to some opinions in opposition to underground systems. One of the "experts" who claimed to be a civil engineer brought up the old and well thrashed subject of ventilation, saying that the proposed road would be even worse in this respect than the London steam roads. Five, and even three, years ago this might have been rational reasoning, but at the present time the idea of using steam locomotives on an underground road ought to be looked at as an antiquated notion which has now merely a historical interest as showing how little was known about electric traction in those bygone days. For a civil engineer to suggest such a system in earnest is to admit his lack of knowledge of modern progress, or to show that he is employed by some interested parties to oppose (at the expense of his reputation) a proposed electric underground road. The use of steam locomotives for underground roads would appear to be almost as much out of the question as the still more antiquated method of using horses. We would suggest to him to read some of the recent literature on this subject, in which he will find that there is an underground electric road in operation in London which has been so successful that there are now six other proposed roads of a similar nature under consideration in that city as well as some in Paris. Besides this, the managers of the steam roads of London are earnestly considering the advisability of changing over to electric traction. Among the other "experts" who testified were a bevy of women, one of whom is a tutor in Greek in the Normal School. Why the committee should have to come down to this, for information, is hard to understand, but it is hoped for their sake that it was not solicited but was forced upon them. When we wish to find out something about Greek we would not be likely to go to electrical or civil engineers; then why should we go to a female Greek tutor to get information on underground electric roads? A clear-headed capitalist contemplating building an underground road would consult a committee of electrical, civil and mechanical engineers; why should not the government do likewise? If the commission intends to put much stress on the testimony of female tutors of Greek, and civil engineers who appear to come from 'wayback, and who do not seem to know that electric motors do not emit smoke nor that electric traction is an accomplished fact—we are afraid that satisfactory rapid underground transit in this city still remains in the far distant future.

Latest Foreign Electrical News.

(By Cable from our Regular Correspondent.)

London, May 30, 1892.—Although many English electricians have from time to time made disparaging remarks concerning the real importance of Mr. Edison's inventions as forming the groundwork for the commercial success of several electrical industries, he has just been paid a high compliment by the Society of Arts, a conservative body of scientific men. This society has awarded the Albert Medal to Mr. Edison in consideration of his distinguished services in the progress of electric lighting, telegraphy and telephony. The Albert Medal was first awarded in 1864, and has often been given to distinguished electricians, among whom may be mentioned Faraday in 1866, Cooke and Wheatstone in 1867, Sir Wm. Thomson in 1879, J. P. Joule in 1880 and Helmholtz in 1888.

A distressing carriage accident occurred on Monday of last week, which resulted in the death of Mr. Willans, the famous builder of engines for electric light purposes. As is well known, the engines of Mr. Willans' design for direct connection to lighting and power generators have come into wide use.

The Crystal Palace exhibition, which has been open to the public for several months, and at which many American exhibits have been shown, will be closed on July 2. This announcement has just been made by the managers.

It will be of interest to those who have watched the somewhat complicated course of storage battery litigation in Europe and America to know that it has just been announced that the Faure patent has been upheld in Germany, where it has been in the courts for some time.

The new telephone company in London is receiving substantial support. It has already obtained 2,500 subscribers to its service, and it proposes to start operations immediately with underground metallic circuits, promising satisfactory service to all customers.

Although the electric railway has not made much progress in this country, it has met with the same opposition that it encountered in the United States in the early stages of its development. The telephone companies are making a vigorous fight to prevent the use of the electric railway in cities where its construction would mean an expenditure of money for the improvement of the existing telephone plants. Two lawsuits are already pending between these two interests, and several injunctions recently obtained are being used to interfere with electric railway progress.

The Manchester municipality has definitely decided to adopt the five-wire system for its electric lighting distribution, and will for this purpose make an expenditure of $600,000.

The joint committee of the House of Lords and the House of Commons has reported to Parliament that after thorough examination of the subject it considers electricity a suitable and efficient source of motive power, and a recommendation is made that the progress of the electric railway should not be impeded, but that, on the other hand, the construction of lines should be encouraged.

Ampere-Centimetre, a Measure of Electromagnetism.

BY A. E. KENNELLY.

The proposition that "every unit length of a circuit conveying one ampère generates a fixed and constant number of lines of force," made by Carl Hering in the last issue of The Electrical World, appears to be indefeasible, at least if the wire be considered filamentary, so that the question of the quantity of force distributed in its interior is excluded from consideration. There may perhaps be some danger of misconstruing the statement, and of assuming that the total number of lines of force, or total flux within a loop formed by a given length of wire, must be the same no matter what shape the loop may assume. This would be a misinterpretation of the above proposition and would be obviously untrue. It would follow at once in that case that the inductance of a given length of wire would be constant, and would not depend upon its coiling. Take the case of a copper wire 100 metres long and one millimetre in radius. Its inductance would be a minimum when it was doubled on itself so as to inclose no area. The two parts of the wire would lie side by side for 50 metres, touching, but thinly varnished so as not to be in electrical contact. The inductance of the circuit under these conditions would be 18.86 microhenrys, and one ampère flowing through the wire would thread 1,886 lines of flux through the loop formed by the axes of the two parts of wire. Now spread out the wire until it forms one circle 1,591 centimetres in radius. Its inductance will be a maximum for any figure that the loop can form, viz., 200 microhenrys, and the flux for one ampère will be 20,008 C. G. S. lines. Between these limits every conceivable degree of intermediate flux inclosed can be obtained by properly reducing the area of the loop.

Suppose that we throw the loop into some irregular shape, and fix it rigidly in the outline it assumes. One ampère circulating in the loop will cause it to embrace a total flux greater than 1,886 and less than 20,003 lines. Call the exact number M. Then, as expressed by Mr. Carl Hering's notation, $M = 10{,}000\ K$. Here 10,000 is the length of wire in centimetres, and K is the constant of flux per unit length corresponding to this particular shape of loop. Now, imagine that all the equipotential magnetic surfaces are described round the loop in tri-dimensional space, and then suppose the linear dimensions of the whole system to be increased in some definite ratio; for simplicity suppose them doubled. The wire's radius will now be 2 millimetres, and its length 20,000 centimetres, and all corresponding linear distances will have become twice as great. It is easy to see that all the equipotential surfaces will have been increased in the same proportion. Their scale of dimensions has increased, but their proportion to each other and relative shape does not vary with the scale; they belong to the shape of the loop. The new system has four times the corresponding surface areas, and eight times the volumes of the original. The flux intensity, B, at all corresponding points in the new system will be just half that in the original, because the equipotential surfaces are now twice as far apart, and upon the gradient of potential or distance between successive equipotential surfaces the intensity depends. At the same time the area through which each corresponding value of B flows is quadrupled in the new system, so that the total flux in the loop will be quadrupled in area and halved in intensity, or just doubled in the aggregate. The flux has been increased in the same ratio as the length of wire, and K retains the same value.

It is evident that K remains unaltered for the same strength of current and the shape of loop, and is independent of the length of wire forming the loop provided that the diameter of the wire is altered in the same ratio as the length. The error introduced into the result by neglecting the latter provision, and keeping the diameter constant, is small when the loop is large compared to the radius of the wire.

The numerical value K is different for different configurations of the wire.

The introduction of iron into the circuit or loop will largely increase the flux and flux density, but will not in any way affect the reasoning as to the result of altering the linear scale of the system considered. If the wire and loop are doubled the iron must be doubled, and all original proportions everywhere maintained.

In practically applying this principle to dynamos, it has to be remembered that if wire is coiled in a number of layers one above another, the outside turns will be longer than those inside and yet their M. M. F. in the circuit will be no greater. In this case ampère feet will not strictly represent M. M. F. Ampère turns will supply the criterion. It is difficult to see how the calculation of total flux in dynamos can receive benefit or simplification from the suggested use of ampère feet, but Mr. Hering's proposition is independently of great interest, and can hardly fail to find practical utility.

Notes on the Magnetic Circuit.

BY CHAS. PROTEUS STEINMETZ.

The name "magnetic circuit" is of rather recent date, though the electrician of to-day is already accustomed to treat magnetism in the same way as the electric current and speak of "magnetomotive force," "magnetic circuit," and "magnetic resistance." He forgets the difference between the magnetic circuit and the electric circuit almost more than he should—for there are essential differences between the magnetic circuit and the electric circuit. Nevertheless it is only a short time since the electrical practice abandoned the old view of "magnet poles," and the magnetic field is not treated any longer as an occasional feature of the electric circuit, but as an essential part of it.

This change in the views with regard to magnetism took place at that time when dynamo building changed from experimental guesswork to theoretical knowledge, and it was our improved knowledge of the magnetic circuit which brought about this change.

But when we know now that every line of magnetic force must return into itself (or, what is the same, run out into infinity), just the same as every stationary electric current must flow in a closed circuit. The first question which offers itself is: "What are the laws which govern the flow of the magnetic current in the magnetic circuit?"

In the electric circuit we have the three quantities:

1. Electromotive force, or difference of electric potential, pressure, tension, etc., measured in volts, E;
2. Electric current, measured in ampères, C, and
3. Electric resistance, measured in ohms, R.

In the magnetic circuit we have the three corresponding quantities:

1. Magnetomotive force, or difference of magnetic potential, measured in ampère turns, F, or absolute units, H;
2. Magnetic current, or magnetic flow, flux, etc., measured in lines of force, or more convenient kilo lines, M, and
3. Magnetic resistance, measured in centimetres or inches, etc., P.

Now, in the electric circuit, these three quantities, E, C, R, are not independent, but depend upon each other by a simple equation, generally called "Ohm's law:"

$$C \times R = E.$$

Hence the question arises, whether the three magnetic quantities, F, M, P, depend upon each other also, and furthermore whether Ohm's law holds for the magnetic circuit, too, in the form:

$$M \times P = F.$$

This is really nothing but a mere question of definition. To see this more plainly, let us examine Ohm's law for the electric circuit.

In a given electric circuit there are really two variable quantities, the electromotive force E, and the current C.

Now experience proves that these two variable quantities of the electric circuit are not wholly independent of each other, but have an approximately constant ratio This ratio,

$$R = \frac{E}{C},$$

is called the electric resistance.

Hence the formula

$$C \times R = E$$

is nothing but the definition of the quantity R, the electric resistance, and therefore correct *a priori*, but it is not Ohm's law yet.

Ohm's law reads:

"The electric resistance defined by the equation $R = \frac{E}{C}$ is a constant of the electric circuit independent of current strength or electromotive force."

This is the true meaning of Ohm's law.

But then Ohm's law is not strictly correct, but holds only under certain limitations, and even then only as approximation.

For, if an E. M. F. of, say, 10 volts sends a current of 5 ampères through an electric circuit, an E. M. F. of say 200 volts will not send 100 ampères through the same circuit, but perhaps very much less.

That means: The electric resistance, as defined by the equation $R = \frac{E}{C}$, is not an "entire constant" of the electric circuit, but depends upon the strength of the current C, indirectly indeed, by way of the rise of temperature caused by the flow of the current; but, nevertheless, it depends.

So we cannot consider R as a constant of the electric circuit, but have to introduce a "temperature coefficient" into R, which makes it dependent upon C; and, what is worse, this dependence contains so many uncontrollable factors (physical condition of the conductor surface, medium which the conductor is in, mechanical conditions of this medium or the conductor, as rest or motion, etc.), that in very many cases, and in most of the conditions of practical use this dependence of the electric resistance upon the current strength cannot be predetermined by exact equations, but can only be approximated.

But, besides this dependence of the electric resistance upon the current strength by way of the temperature, there are other dependencies of the electric resistance of very much less importance indeed. Let us leave out of consideration the dependence of the resistance upon variations of the current, as a "spurious resistance" appearing in alternate current circuits, for instance, because this is really no resistance at all, but caused by a true E. M. F., which has to be included in E to make Ohm's law hold for varying and alternating currents, as well as for steady currents.

But, well marked in a few materials, as bismuth, a magnetic field has an influence upon the electric resistance, too, and, an electric current producing a magnetic field of its own, this phenomenon makes the electric resistance depend upon the current strength once more.

Hence, to make Ohm's law hold exactly for the electric circuit, that is to establish a rigid equation between C and E, of the form $E = C\,R$, we would have to introduce into R the temperature of the conductor, the strength of the magnetic field, or perhaps soom more dependencies. Considering the electric circuit from this point of view, with the resistance as a variable quantity, and as a function of the physical conditions of the circuit, we find very similar phenomena in the magnetic circuit.

Magnetomotive force, F, is defined in ampère turns, and magnetism, M, in lines of magnetic force, and have meanings of their own, from their physical properties.

But "magnetic resistance" or "reluctance" P has no direct meaning, but has to be defined first, and then the most convenient definition of "magnetic resistance," and analogous to "electric resistance" is the ratio of magnetomotive force and magnetism or magnetic current:

$$P = \frac{F}{M}$$

And then the equation $F = P\,M$ holds for the magnetic circuit just as well as the corresponding deduction $E = R\,C$ holds for the electric circuit; but it is not Ohm's law, but the definition of the term "magnetic resistance" or "reluctance."

Then the question comes up whether the quantity "magnetic resistance P" is a constant of the magnetic circuit independent of F and M, or at least constant under certain conditions, like R in the electric circuit.

For most of the existing materials, at least as far as we can determine, the magnetic resistance P is an "entire constant," much more constant than the electric resistance R. Only very few materials are excepted among them, indeed, the most important and best magnetic conductors.

Hence we can claim Ohm's law for the magnetic circuit with much more right than for the electric circuit.

For only in the magnetic circuit is the resistance P an absolute quantity, in the equation $F = P\,M$, whil

in the electric circuit the resistance R is variable with the temperature, etc.

Only a few materials, as before stated, make an exception of this Ohm's law of the constancy of magnetic resistance P, and these are especially iron, nickel and cobalt, and some of their alloys and combinations. Perhaps also a number of others, "diamagnetic" materials, like bismuth, antimony, etc., but there in much less marked degree.

In these materials we find the magnetic resistance decidedly dependent upon the density of the magnetic current, that is, upon the number of lines of magnetic force passing through the unit of cross section of the magnetic conductor.

Hence, with these materials, in the quantity "magnetic resistance" P, or its inverse value, "magnetic conductivity," or "permeability" μ enters the term "magnetic density" or "field intensity," just as in the term "electric resistance," viz., "electric conductivity" enters the coefficient "temperature."

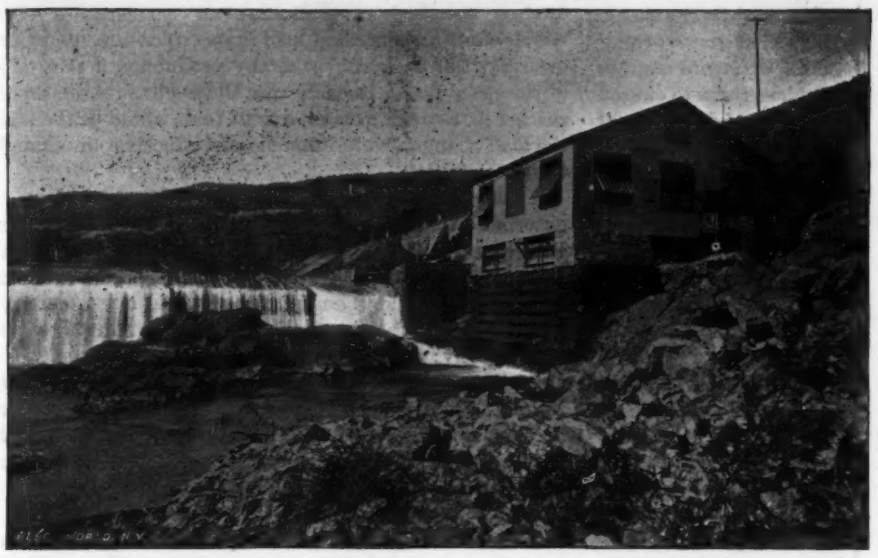


FIG. 4.—EXTERIOR OF THE POWER HOUSE.

But unfortunately it is not only the magnetic density existing in the magnetic conductor which determines its magnetic resistance, but also, especially for low magnetization, the magnetic density which existed before (phenomenon of permanent and remanent magnetism. difference between the permeability for rising and for decreasing magnetization).

At the same time, for lower magnetization, the magnetic conductivity depends upon other conditions and can, for instance, by mechanical or magnetic vibrations, sometimes be increased several fol

All this makes the magnetic circuit for lower magnetization appear in a kind of unstable equilibrium.

For higher magnetization, indeed, especially from that point where the characteristic curve of magnetization has its "knee" and begins to approach saturation, the difference between the rising and falling curve, the influence of remanent and permanent magnetism, of mechanical vibration, etc., more and more disappears, and the magnetic circuit comes more into a stable equilibrium, its magnetic current depending only upon the existing conditions.

Hence, to make use of the equation of the magnetic circuit

$$F = P\,M$$

for calculation—and we are obliged to use this equation to be able to calculate magnetic circuits at all—the dependence of P, viz., μ upon the magnetic density, or field intensity, has to be known.

To express this dependence by a mathematical equation which will fit all conditions, all attempts until now failed, and everybody who ever examined and compared a large number of magnetic characteristics of different materials will not wonder about that, but on the contrary will concede it very unlikely to bring all these different shapes of magnetic curves under the same equation.

Very many analytical expressions, indeed, have been proposed: Frölich's hyperbolic formula, Kapp's *arcus-tangens* function, exponential functions, infinite series, etc.; but they all have in common that they are not correct for medium magnetization, wrong for higher saturation, and do not even intend to express the phenomena for low magnetization.

For a limited range, indeed, but fortunately that range of magnetization that is used in practical designing, a very fair approximation can be reached by replacing M, the whole magnetism, by $M + K$, where K is the magnetism which would pass through the air if no iron were present, and which can easily be calculated.

Then putting $M = \dfrac{F}{P_0}$

P_0 can be expressed by the equation

$$P_0 = a + b\,F,$$

giving as general formula

$$M = M + K = \frac{F}{a + b\,F} + K.$$

Only for low magnetization this equation does not hold any more, and in the formula for P_0 a term of the form $c\,e^{-d\,F}$ has to be added, giving:

$$P_0 = a + b\,F + c\,e^{-d\,F}$$

where the constants a, b, c and d depend upon the dimensions of the magnetic circuit and the constants of the iron.

To consider only the simplest case—because all the other cases can be reduced to that—of an iron piece of cross section s in cm²; length, l in cm.

M. M. F. acting upon it (that is, difference of magnetic potential between its ends, if no inside M. M. F. acts, or M. M. F. of exciting current in a closed ring of uniform cross section) $= F$, in ampère turns,

then it is $$P_0 = \frac{\rho\sigma\,l}{s}$$

and $\rho\sigma = \alpha + \dfrac{\beta\,F}{l}$, where α and β are constants of the iron

and $$K = \frac{4\pi}{10}\,\frac{F\,s}{l}$$

Therefore the "metallic magnetic reluctivity" can be expressed by:

$$\rho\,o = \alpha + \beta\,\frac{F}{l}$$ (Kennelly.)

The values of α, the coefficient of magnetic hardness, I found varying in wrought iron from $\alpha = .16 \times 10^{-3}$ (Norway iron) up to $.35 \times 10^{-3}$ (ordinary sheet iron) in cast iron; $\alpha =$ 1 to 2×10^{-3} gives a fair average.

In steel I found for α values as low as $.23 \times 10^{-3}$ in a sample of very soft annealed cast steel, while in glass hard tool steel I observed $\alpha = 9.8 \times 10^{-3}$.

The "coefficent of magnetic saturation" β varies in wrought iron between .05 and .06 $\times$ 10^{-3}; in cast iron it is about .08 to $.09 \times 10^{-3}$, while in steel I found values covering the whole range from

$$\beta = .055 \times 10^{-3} \text{ up to } \beta = .1 \times 10^{-3}.$$

More about these magnetic constants of the iron I shall give on a later occasion.

Test of the Neversink Mountain Electric Road.—II.*

BY HERMANN S. HERING AND WM. S. ALDRICH,
OF JOHNS HOPKINS UNIVERSITY.

THE POWER HOUSE.

Location and Building.—The power house is located by the Schuylkill River, at the big Reading dam, near the Klapperthal station on the main line of the Philadelphia & Reading Railroad. Its distance from the main depot, in the city of Reading, is 3.4 miles along the railroad; from the city centre, intersection of Fifth and Penn streets, it is on the 2.25 mile circle; being just below the Klapperthal terminal of the mountain road, it is 4.07 miles by the short line, and 6.99 miles around the mountain from the Ninth and Penn street terminal.

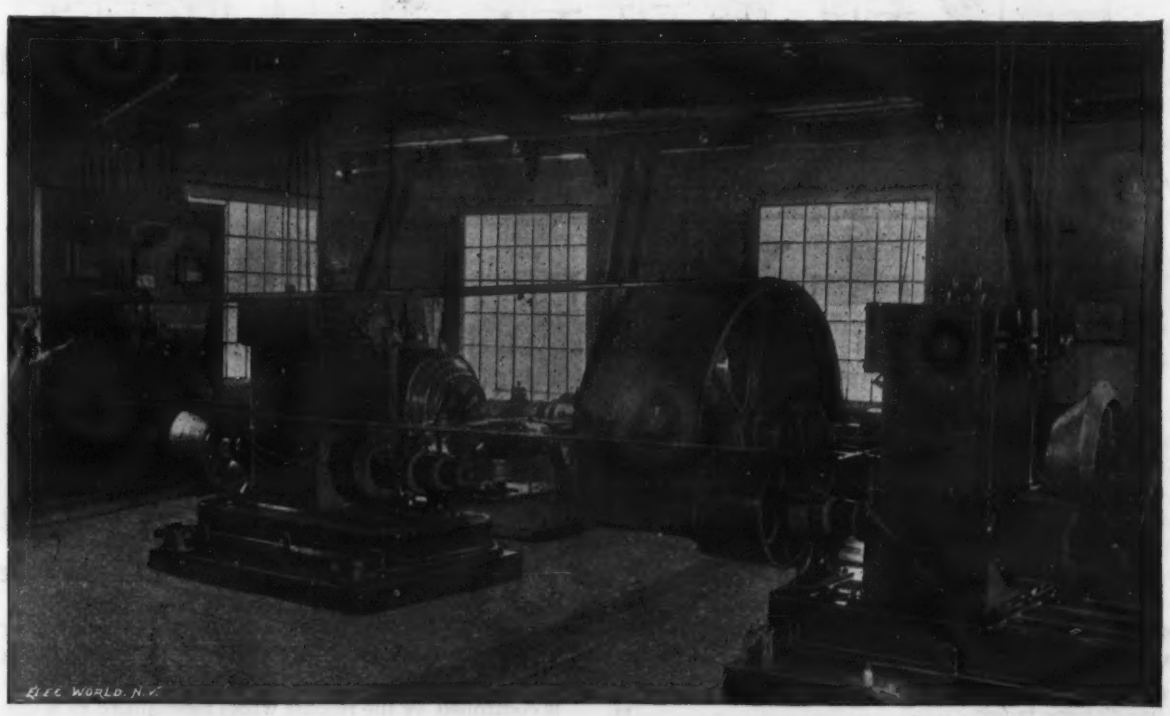


FIG. 6.—INTERIOR OF THE POWER HOUSE OF NEVERSINK MOUNTAIN R. R.

The building is a frame structure, one story in height, 40×42 feet in plan, and built on cribwork, projecting out from the rocky ledge or declivity between the Philadelphia & Reading Railroad tracks and the river bank. Fig. 4, taken from a photograph made especially for THE ELECTRICAL WORLD, is a view of the power house, looking northwest, which shows its characteristic location, a part of the dam and the Neversink Mountains in the background. Two portions of the road can be seen on the mountain side; the upper cut being the summit and the lower one the curves between the upper junction and the trestle.

The cribwork surrounds and forms part of the two penstocks as well as the forebay, placed about in the centre of the building, as will be seen in the ground plan in Fig. 5. From the top of the cribwork to the level of the available flood water is 5.44 feet, which is filled in with masonry work, and forms, with the masonry on the rocky ledge, the continuous foundation of the building. The cribwork, being below the level of the waste-water trough, is kept constantly wet. The countershaft pedestals rest on substantial masonry built out from the rocky ledge. The jack shaft pedestals rest on cross beams, set into the masonry on top of the cribwork, as will be seen in Figs. 5 and 7. The dynamos rest upon cross beams similarly placed.

Fig. 6 shows the interior of the power house. The jack shaft, main driving pulley and the casings for the bevel gears are seen in the rear, on the river side. The view is taken from the north end of the countershaft.

Flume Construction.—The flume leading from the forebay is of wrought iron, 0.375 inch thick, 10 feet diameter, and extends for about 100 feet to the screen box in the coffer dam. The screen is located at a small angle to the main direction of the river current, in order that the screenings may be washed away. The abutment, built out from the rocky ledge to the shore-end of the dam is of substantial stone masonry, and the general arrangement will be seen in Fig. 5.

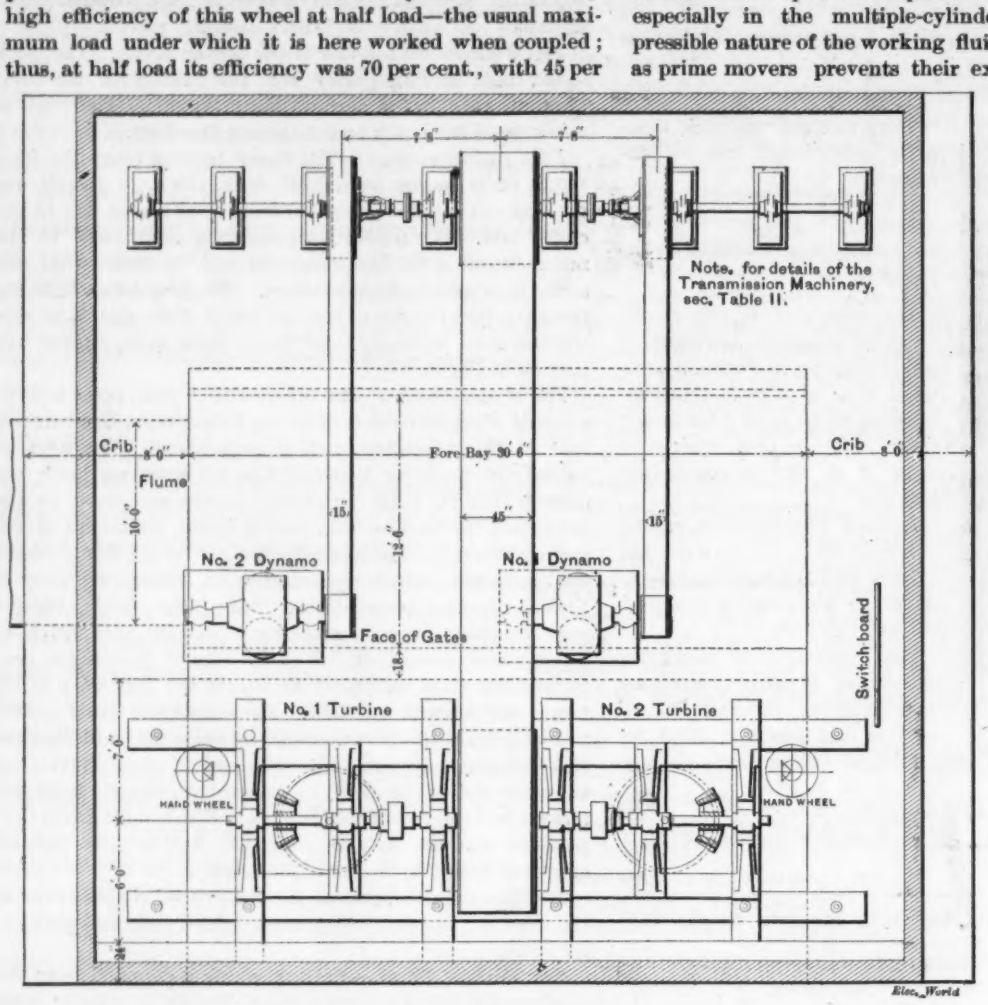
The Water Power.—The Schuylkill at this point follows a nearly straight course, after the Horse Shoe Bend at the foot of the mountain, half a mile above. The average velocity of the river is from 1.5 to 2.5 miles per hour; the dam is 423 ft. long, extending across the river to the Schuylkill Navigation Company's canal, where one of the locks is located. The mean discharge over the dam is about 500 cu. ft. per second, representing an average capacity of 1,000 hydraulic horse power. Two other dams, located near Reading, have a combined capacity of 1,000 h. p. These water power facilities of the city of Reading appear to be more than sufficient to supply the city with light, power and electric traction. The aggregate water power available from the dams, owned by the Schuylkill Navigation Company, appears to be sufficient to supply several of the cities and towns along its course with electric light and power; but the Neversink Mountain Electric Railroad Corporation was the first to make use of this great natural source of power by means of electricity.

The flow over these dams is to be depended upon, even in the very dry or very cold seasons, which adds materially to its value.

The Turbine Plant.—Each penstock is supplied from the forebay through a main flood gate, which is usually kept fully open while the turbines are running. In the penstocks are 45-inch Hercules turbines, each having independent speed gates, which are controlled respectively by independent hydraulic governors. The general arrangement of the turbine plant is shown in Fig. 7. The vertical shaft of each turbine is carried up, through a coupled shaft, to a mortised crown gearwheel driving an iron jack gearwheel on the horizontal jackshaft, above the turbines. This shaft is made in three sections, connected by two positive clutch couplings, so that the main driving pulley, on the central section, may be driven by either or both turbines. These are rated at 240 nominal horse power each, and at present drive two 100 k. w. Edison railway generators. Floor space has been left, and sufficient countershaft capacity has been arranged to about double this electrical equipment; but, as the station is now run, both turbines are used coupled, and at about three-quarters of their hydraulic capacity when driving the two dynamos in parallel at about their full load. Though one turbine is amply sufficient for the average capacity of the road, as at present equipped, the second turbine is a reserve source of motive power. The use of one turbine, as may be inferred from the results of the test, would be recommended from the standpoint of its hydraulic efficiency, a feature clearly brought out in the characteristic curves of the Hercules turbine.

* For the first section of this article see THE ELECTRICAL WORLD of May 28, 1892.

The use of both turbines, coupled to one shaft, results in a low hydraulic efficiency for each turbine for the average maximum load of the road, and gives a very uncertain regulation as controlled by the present hydraulic governors. The plotted results of the tests show that it is still an open question whether it is advantageous to couple turbines as prime movers with independent speed governors. These turbines were made by the Holyoke Machine Company, Worcester, Mass. The diagrams showing the individual performance of the turbines will clearly indicate the very high efficiency of this wheel at half load—the usual maximum load under which it is here worked when coupled; thus, at half load its efficiency was 70 per cent., with 45 per



cent. gate opening and running at its critical speed, for this gate, of 100 revolutions per minute.

TABLE NO. I.

Water supply:	
Flume, diameter in feet	10
Nominal head of water, in feet	18
Hercules turbines:	
Diameter, in inches	45
Effective area of guide opening, square inches	623
Rated speed, revolutions per minute	110
Commercial rated performance, full gate:	
Rated discharge of each turbine, cubic feet per minute	8,833
Rated efficiency, full gate and rated speed, in per cent	80
Rated horse power, at this efficiency, each turbine	240
*Actual performance at full gate:**	
Actual discharge, each turbine, cubic feet per minute	8,588
Actual efficiency, 110 revolutions, in per cent	80.7
Maximum dynamometric horse power, each turbine	210
Actual performance, about half gate:	
Mean position of speed gate, being the proportional part of the full opening of the speed gate, in per cent	53.3
Actual discharge at critical speed for this gate, cubic feet per minute	5,528
Efficiency, critical speed 100, in per cent	75.37
Efficiency, rated speed of 110	74.4
Actual dynamometric horse power of each turbine at the critical speed of 100 revolutions per minute	132.5
Actual dynamometric horse power of each turbine at the rated speed of 110 revolutions per minute	128.5

* The data relating to the actual performance of the turbines are obtained from the results of a test of the Hercules turbine made by the Holyoke Water Power Company, and kindly furnished the authors by them.

Owing to the uncertain limit of the probable maximum load in electric traction work, it is necessary to operate the turbines as prime movers at a point much below their known capacity at full gate, because of their inability to develop any greater power than that represented at full gate and normal speed. This is an analogous case to that of the series motor. Steam engines, on the contrary, as prime movers in electric traction work are capable of far exceeding their known rated capacity to meet the large and sudden loads which are on only for a short time, by reason of the possibilities bound up in the expansive working of the steam, especially in the multiple-cylinder type. The incompressible nature of the working fluid employed in turbines as prime movers prevents their exceeding the output, as determined by the dimensions of the machine, while the elastic nature of the working fluid in steam engines enables them to exceed their rated dimensional capacity for extraordinary demands. Consequently, for electric traction work, turbines must be operated considerably below their maximum capacity, or at part gate during the average maximum loads of the day, so that they will be able to meet the extraordinary loads that will be sure to arise at unexpected times. As it will be necessary for constructing engineers to select turbines that will be efficient at part gate, and particularly at the ordinary maximum of half gate, it becomes the aim of turbine builders to design wheels for traction purposes to meet these particular requirements.

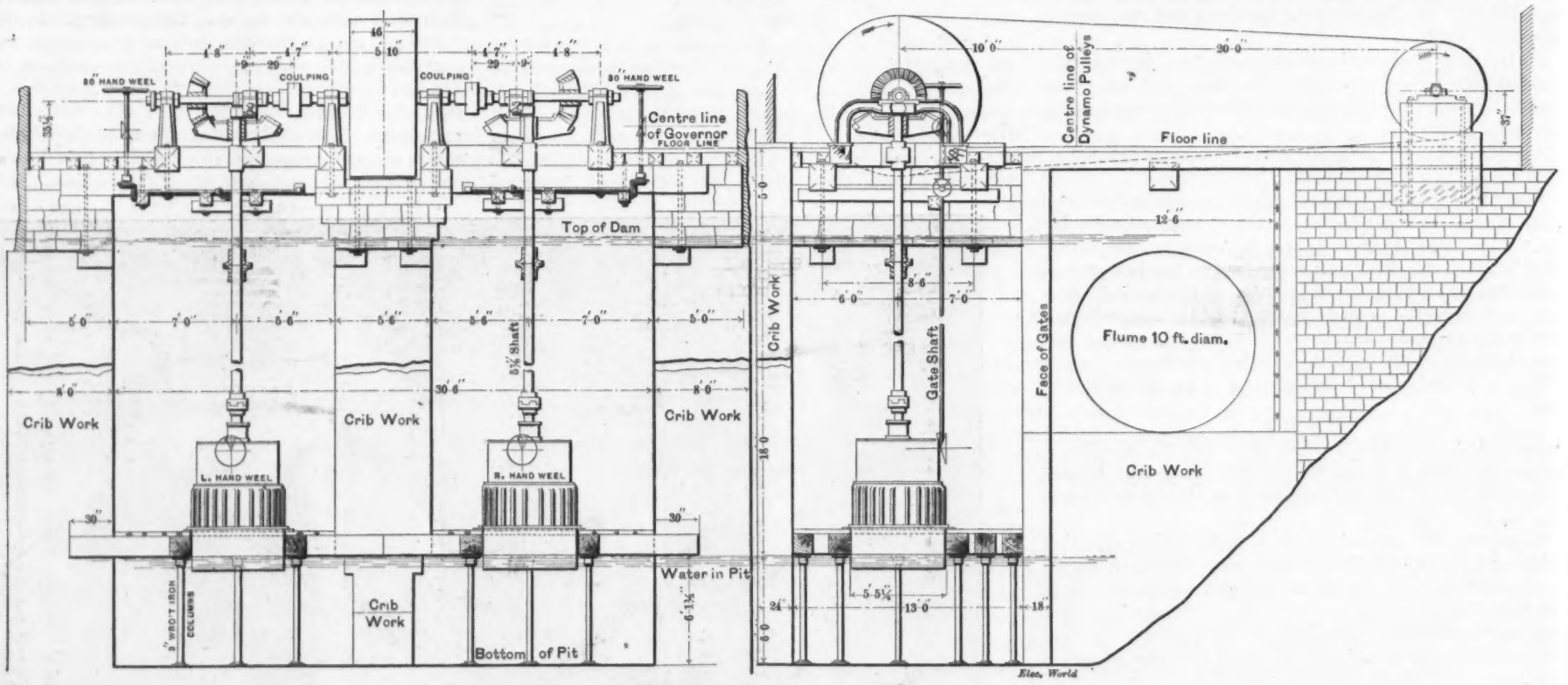


FIG. 7.—PLAN, ELEVATION AND RIGHT SIDE VIEW OF THE TURBINE PLANT.

The Turbine Governors.—The speed regulation of the turbines is through a Pritchard Electric Waterwheel Governor for each turbine. The position of the speed-gate is controlled by the ratchet wheel mechanism in a step-by-step manner, as with the ordinary turbine governors. The clutch of the ratchet wheel is operated by a simple electromagnetic device, which throws it into or out of gear. The electromagnet is actuated by an electric current, controlled by a horizontal contact arm, whose position is determined by the vertical movements of the spindle of an ordinary fly ball governor. Changes of load in the external circuit of the dynamos must be transmitted through the two belts of the transmission machinery, before being felt at the jacksh aft, and then through one governor belt, before the resulting speed changes of the jackshaft are felt at the governor spindle. Therefore, reasonably small variations of the dynamo load, and the consequent small speed changes of the turbines, result in a slight and indefinite movement of the governor balls. This causes an oscillation of the horizontal contact arm, between the upper and lower points, without actually making electric contact. Any considerable variations, however, produce decided alterations in the position of the governor balls, and so hold the horizontal contact arm against either the upper or lower contact piece till the resulting operation of the turbine governor has so affected the position of the speed-gate and the water supply as to restore the speed of the turbines more or less to their normal condition. Obviously, therefore, no small interval of time intervenes between the dynamo load changes and the action of the governor balls on the one hand, and from the consequent operation of the contact arm to the effective opening or closing of the speed-gate, on the other. The usual interval of time between the dynamo load changes and the operation of the ratchet is about five seconds; and between the dynamo load changes and the restoration of the normal speed is from 20 seconds to one minute, according to the extent of variation. Decreased load results in the station momentum being more or less absorbed in producing an acceleration of the speed, while an increased load draws upon the momentum to supply the deficiency, thereby producing a retardation of the speed; and, in each case these changes are thereby carried to a much greater extent than would be the case if the load changes were immediately effective in changing the gate position.

A solenoid mechanism, operated by a shunt from the external circuit, might be used to move the horizontal contact lever, instead of the flyball governor to which speed changes are transmitted through three belted connections; the ratchet would then be thrown into operation immediately, and consequently the speed gate started to close immediately; thus in a very large measure preventing the alteration of momentum from affecting the speed so materially. Owing to the serious results that would follow from a very quick closing of the speed gates, no rapid method of regulating the flow of water is possible, but a prompt action of the ratchet mechanism will largely modify the excessive variations.

Another method would be to operate the ratchet directly from the external circuit, or even to operate the speed gates directly by an electromagnetic mechanism. These load governing devices are only effective when the dynamos are in operation, and therefore some centrifugal governors, mechanically operating the speed-gates, would be required to take care of the turbines when the dynamos are not running, or in the event of their becoming disabled.

No. 1 turbine in this station has its governor set more sensitively than No. 2. Often under light loads turbine No. 2 is operated at a fixed gate opening of 17.4 per cent. of the full gate, in which case the more sensitive governor of No. 1 does all the regulating. Much closer regulation would result from controlling both speed-gates by a single governor, instead of a governor for each gate.

The Transmission Machinery.—As will be seen by referring to Fig. 7, the jackshaft, over the turbines, is driven from the vertical turbine shaft, through bevel gears, and drives the countershaft through the main belt. Each dynamo pulley is belted to the friction clutch pulley on the countershaft.

The essential details of the transmission machinery are shown in the following table:

TABLE NO. II.

Geared and belted connections:	
Number of teeth on mortised crown gear, vertical shaft	49
Number of teeth on jack gear, horizontal shaft	31
Diameter of main driving pulley, in inches	108
Diameter of main driving pulley, on counter shaft	66
Diameter of driving pulleys (friction clutch)	60
Diameter of pulleys of dynamos	26
Main driving belt, extra double, width in inches	45
Dynamo belts, double, in inches	15
Lengtv of main driving belt, in feet	83
Rated speeds:	
Turbine shaft (vertical), revolutions per minute	110
Jackshaft over turbines	175
Countershaft	286
Dynamos	650
Speed of main driving belt, feet per minute	4,950
Speed of dynamo belts	4,300
Distances between shaft centre lines:	
Between the vertical shafts of the turbines, in feet	16.5
Between the jackshaft and countershaft	30
Between the countershaft and dynamos	20

The transmission of the turbine power through the mortise crown and jack gear leads to quite a loss. On the other hand, the two belted connections to an intermediate countershaft result in the usual loss of power experienced in stations driven by steam engines. These losses are grouped under transmission machinery friction in the summary of the test.

The additional loss through bevel gearing is inherent in this method of transmitting the power from the prime mover shaft to the main driving shaft. The efficiency of the transmission machinery, however, will be the same as in steam engine plants, when the turbine shaft (like the crankshaft) is the main driving one. Similarly, driving the dynamos by one belt from the turbine shaft is but an intermediate step to driving them directly coupled, as has been projected at the Niagara plant,* and which is, of course, the most efficient method.

The turbine plant and the equipment of the transmission machinery were installed by the Holyoke Machine Company, Worcester, Mass.

The Dynamo Plant.—As at present equipped, there are two Edison compound wound, 100 k. w. railway generators. Each dynamo has complete switchboard connections, field resistances, ammeters, fuses and switches, and either or both may be connected with the line circuit, and be driven by either or both turbines.

Lightning arresters are carefully placed in each feeder circuit.

The electrical equipment of the power house was installed by Chadbourne, Hazelton & Co. (The Equitable Equipment and Construction Company) in co-operation with the Sprague Motor Company of that time.

The results of the test show that large variable loads on the line cause great speed variations in the turbines, as here governed and coupled, resulting in considerable drop in the voltage at one time and rise at another. Even with the best method of governing turbines in present use these voltage variations will still be great, indicating that the dynamos for such plants should be very much over compounded.

The building is lighted by 20 Edison lamps of 16 c. p. at 100 volts, five in series; 15 of the lamps being distributed about the ceiling and five on the switchboard.

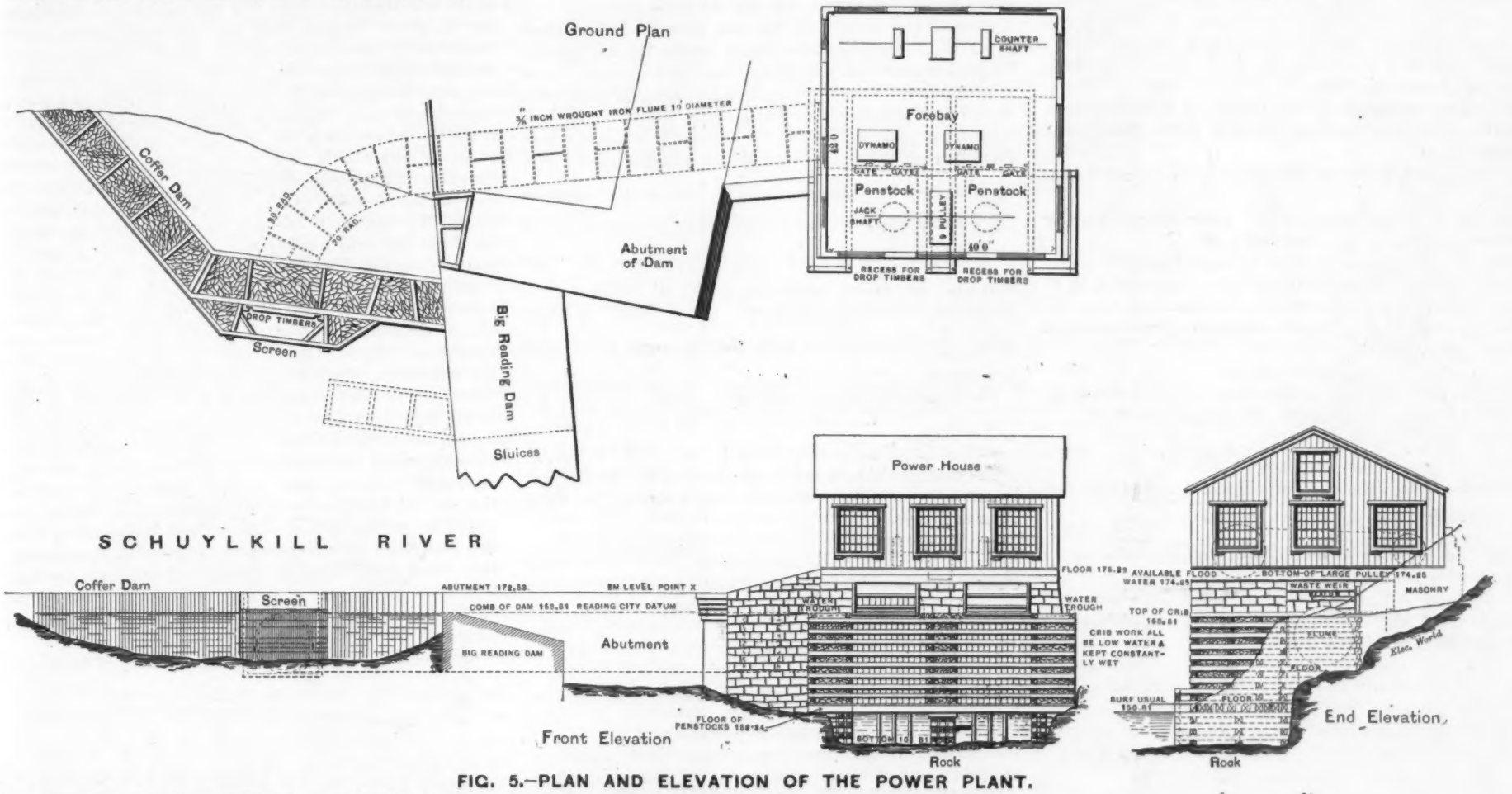


FIG. 5.—PLAN AND ELEVATION OF THE POWER PLANT.

The Elementary Principles Necessary to Establish the Equation of Electromotive Forces for a Circuit Containing Resistance and Capacity—IV.†

BY FREDERICK BEDELL AND ALBERT C. CREHORE.

In the previous paper the equation of energy for a circuit containing ohmic resistance and capacity was derived, and, by dividing the equation of energy through by $i\,dt$ or dq, it was found that the equation of electromotive forces thus obtained may be expressed in terms of current i or charge q, thus:

$$e = R\,i + \frac{\int i\,dt}{C} \qquad (1)$$

$$e = R\frac{dq}{dt} + \frac{q}{C} \qquad (2)$$

Differentiating (1), to free it from the integral sign, and transposing, the two equations may be written:

$$C\,de - R\,C\,di - i\,dt = 0 \qquad (3)$$

$$0\,de - R\,C\,dq + (e\,C - q)\,dt = 0 \qquad (4)$$

Each of these equations is a differential equation of the first order with three variables, e, i and t, and e, q and t, respectively, of the form,

$$P\,dx + Q\,dy + S\,dz = 0 \qquad (5)$$

If there exists a single integral equation of which (3) or (4) is the exact differential, the condition of integrability

$$P\left(\frac{dQ}{dz} - \frac{dS}{dy}\right) + Q\left(\frac{dS}{dx} - \frac{dP}{dz}\right) + S\left(\frac{dP}{dy} - \frac{dQ}{dx}\right) = 0 \qquad (6)$$

must be satisfied.

Applying this criterion of integrability to the equations

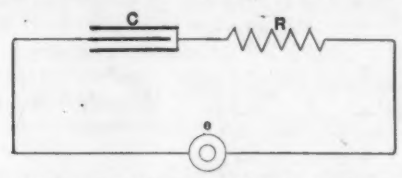


FIG. 8.—CIRCUIT HAVING OHMIC RESISTANCE AND CAPACITY.

(3) and (4), it is found that the condition is not satisfied by either equation. No single equation exists, therefore, of which (3) or (4) is an exact differential.

But, as was previously stated, we know that the electromotive force e may always be expressed as a single valued function of the time, since it must have some one value at each point of time, and we have

$$e = f(t) \qquad (7)$$

where f is an arbitrary single valued function. By differentiation (7) becomes

$$\frac{de}{dt} = f'(t) \qquad (8)$$

Equations (3) and (4) may now be written in the linear form thus,

$$\frac{di}{dt} + \frac{i}{RC} = \frac{1}{R}f(t) \qquad (9)$$

$$\frac{dq}{dt} + \frac{q}{RC} = \frac{1}{R}f(t) \qquad (10)$$

The solutions of these linear equations are

$$i = \frac{\varepsilon^{-\frac{t}{RC}}}{R}\int \varepsilon^{+\frac{t}{RC}} f(t)\,dt + c\,\varepsilon^{-\frac{t}{RC}} \qquad (11)$$

$$q = \frac{\varepsilon^{-\frac{t}{RC}}}{R}\int \varepsilon^{+\frac{t}{RC}} f(t)\,dt + c_2\,\varepsilon^{-\frac{t}{RC}} \qquad (12)$$

The integrals here expressed cannot be found unless we know in what particular way the electromotive force varies with the time. When we know this, these equations, (11) and (12), will give the values of the current and charge at any time, provided the integral sought can be obtained. We will now assume several ways in which the E. M. F. varies with the time, which will allow the integration to be easily performed.

Case I. Discharge of a Condenser.—Suppose that a constant source of E. M. F., E, has been acting upon a circuit containing in series a resistance, and a condenser with capacity C, until everything has reached its steady state. No current will be flowing, and the condenser will be charged with a quantity Q, and have a difference of potential E at its terminals. Now suddenly remove the source of E. M. F. from the circuit and suppose its resistance then is R. The condenser will immediately begin to discharge through the conductor, and we wish to find the value of the charge q and current i at any time after the discharge begins.

When the E. M. F. was removed from the circuit the impressed E. M. F., e, $= f(t)$, became equal to zero at every point of time after the removal; hence, substituting

$$e = f(t) = 0 \qquad (13)$$

in the general equations (11) and (12), we find that the integral vanishes, and we have the immediate results,

$$i = c_1\,\varepsilon^{-\frac{t}{RC}} \qquad (14)$$

$$q = c_2\,\varepsilon^{-\frac{t}{RC}} \qquad (15)$$

The arbitrary constants c_1 and c_2 are determined by the initial conditions. If the charge is Q when the time is zero (15) becomes,

$$q = Q\,\varepsilon^{-\frac{t}{RC}} \qquad (16)$$

and q, since $dq = i\,dt$, (14) becomes,

$$= -\frac{Q}{Rc}\,\varepsilon^{-\frac{t}{RC}} \qquad (17)$$

If instead of substituting $e = f(t) = o$ in the general solutions (11) and (12), we had substituted in the differential equations (9) and (10), it is seen that the second member of each becomes zero, and that the solutions are merely the complementary functions, namely, the terms in the general solutions containing the arbitrary constants, as pointed out.

It may be of interest to derive the solution directly from the differential equations, since the variables easily admit of separation.

Equation (10), when $f(t) = 0$, is

$$\frac{dq}{dt} + \frac{q}{RC} = 0. \qquad (18)$$

Hence $$\frac{dq}{q} = -\frac{dt}{RC}$$

and $$\log\frac{q}{c} = -\frac{t}{RC}$$

or $$q = c\,\varepsilon^{-\frac{t}{Rc}} \qquad (19)$$

which is identical with (15).

In Fig. 9 is shown a curve of discharge of a condenser for a particular case. The rapidity of discharge is shown by the value of the time constant T, which gives the time in which the charge of the condenser is reduced to one εth of its initial value.

$$T = R\,C = 100 \times 10^9 \times 4 \times 10^{-15} = .0004 \text{ seconds.}$$

Case II. Charge of a Condenser.—Suppose that a constant source of E. M. F., E, is suddenly introduced into a circuit, and that the resistance when it is introduced is R, the capacity of the condenser in series with the resistance being C.

The values of the current i and charge q at any time after the introduction of the E. M. F. will be given by equations (11) and (12) if we suppose,

$$e = f(t) = E, \text{ a constant.} \qquad (20)$$

and consequently $$\frac{de}{dt} = f'(t) = 0. \qquad (21)$$

Substituting these values, (11) and (12) become

$$i = c_1\,\varepsilon^{-\frac{t}{RC}} \qquad (22)$$

$$q = C\,E + c_2\,\varepsilon^{-\frac{t}{RC}} \qquad (23)$$

Determining the constants of integration c_1 and c_2 by the condition that there was no charge in the condenser when $t = 0$, we have, $c_2 = CE$.

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* For description of the Niagara plant see THE ELECTRICAL WORLD, Feb. 6, 1892.

† For the first three sections of this article see THE ELECTRICAL WORLD, May 14, p. 334; May 21, p. 349, and May 28, p. 336.

But since $CE = Q$, the final charge of the condenser when everything has reached its steady state, (23) b-comes

$$q = Q\left(1 - \varepsilon^{-\frac{t}{RC}}\right), \tag{24}$$

and by the relation $dq = i\,dt$ equation (22) becomes

$$i = -\frac{Q}{RC}\,\varepsilon^{-\frac{t}{RC}} \tag{25}$$

It is noticeable that the equations for the current (17) and

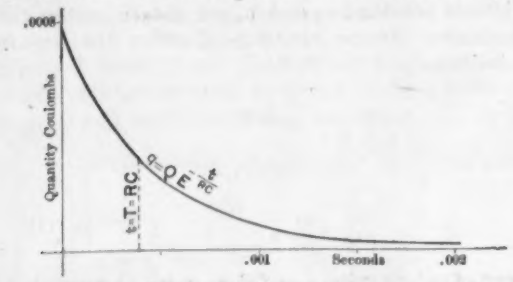


Fig. 9.—Curve Showing Discharge of a Condenser whose Capacity C = 4 Microfarads, Through a Resistance R = 100 Ohms.

(25) are identical in the case of charge and discharge of a condenser.

Equation (24) may easily be derived from the differential equation (10) directly upon substituting of $f(t) = E$, as the variables easily admit of separation, thus,

$$\frac{dq}{dt} + \frac{q}{RC} = \frac{E}{R}, \tag{26}$$

may be written $\dfrac{dq}{q - CE} = -\dfrac{dt}{RC}$,

and $\log \dfrac{(q - CE)}{c_2} = -\dfrac{t}{RC}$.

Hence $q = CE + c_2\,\varepsilon^{-\frac{t}{RC}}$ (27)

which is identical with (23).

The curve representing the charge of a condenser is shown in Fig. 10. The time constant $RC = .0004$. The final charge is

$Q = C\,V = 4 \times 10^{-15} \times 200 \times 10^{8} \times 10 = .0008$ coulombs.

The curve of discharge for this same condenser under the same conditi ons was given in Fig. 9.

Case III. Electromotive Force a Simple Harmonic Function of the Time.—Let us now suppose the impressed E. M. F. to be a simple harmonic function of the time, as in Case III in the paper discussing circuits containing resistance and self-induction, that is,

$$e = f(t) = E \sin \omega t \tag{28}$$

where E is the amplitude, or maximum value of the E. M. F., and w the angular velocity. By differentiation,

$$\frac{de}{dt} = f'(t) = E\,\omega \cos \omega t \tag{29}$$

Substituting these values in the general equations (11) and (12), we obtain

$$i = \frac{E\,\omega}{R}\,\varepsilon^{-\frac{t}{RC}} \int \varepsilon^{+\frac{t}{RC}} \cos \omega t\,dt + c_1\,\varepsilon^{-\frac{t}{RC}} \tag{30}$$

$$q = \frac{E}{R}\,\varepsilon^{-\frac{t}{RC}} \int \varepsilon^{\frac{t}{RC}} \sin \omega t\,dt + c_2\,\varepsilon^{-\frac{t}{RC}} \tag{31}$$

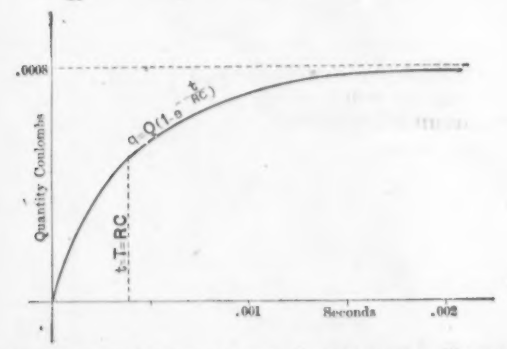


Fig. 10.—Curve Showing the Charge of a Condenser whose Capacity C = 4 Microfarads when Subjected to a Difference of Potential of 200 Volts Through a Resistance of 100 Ohms.

These integrals may be found by the formulas of reduction, obtained by integrating by parts, namely,

$$\int \varepsilon^{mx} \cos(nx + \alpha)\,dx = \frac{\varepsilon^{mx}}{m^2 + n^2}\left\{n \sin(nx + \alpha) + m \cos(nx + \alpha)\right\} \tag{32}$$

$$\int \varepsilon^{mx} \sin(nx + \alpha)\,dx = \frac{\varepsilon^{mx}}{m^2 + n^2}\left\{m \sin(nx + \alpha) - n \cos(nx + \alpha)\right\} \tag{33}$$

Applying these formulas of reduction to equations (30) and (31) they become,

$$i = \frac{C^2 E\,\omega}{1 + C^2 R^2 \omega^2}\left(\omega \sin \omega t + \frac{1}{RC} \cos \omega t\right) + c_1\,\varepsilon^{-\frac{t}{RC}} \tag{34}$$

$$q = \frac{C^2 E R}{1 + C^2 R^2 \omega^2}\left(\frac{1}{RC} \sin \omega t - \omega \cos \omega t\right) + c_2\,\varepsilon^{-\frac{t}{RC}} \tag{35}$$

These equations (34) and (35) may be simplified by the trigonometric formula,

$$A \sin\theta + B \cos\theta = \sqrt{A^2 + B^2}\,\sin\left(\theta + \tan^{-1}\frac{B}{A}\right). \tag{36}$$

By the application of this formula to (34) and (35) we have the complete solutions of the differential equations, namely,

$$i = \frac{E}{\sqrt{R^2 + \frac{1}{C^2\,\omega^2}}} \sin\left\{\omega t + \tan^{-1}\frac{1}{C\,R\,\omega}\right\} - \frac{t}{RC} + c_1\,\varepsilon \tag{37}$$

and,

$$q = \frac{E}{\omega\sqrt{R^2 + \frac{1}{C^2\,\omega^2}}} \sin\left\{\omega t - \tan^{-1}\frac{1}{C\,R\,\omega}\right\} - \frac{t}{RC} + c_2\,\varepsilon \tag{38}$$

Equation (38) is equivalent to,

$$q = \frac{-E}{\omega\sqrt{R^2 + \frac{1}{C^2\,\omega^2}}} \cos\left\{\omega t + \tan^{-1}\frac{1}{C\,R\,\omega}\right\} - \frac{t}{RC} + c_2\,\varepsilon \tag{39}$$

These equations (37) and (39) are the complete solutions, expressed in their simplest forms. It will be noticed that the differential of (39) is (37), according to the relation $dq = i\,dt$. It was not necessary to carry both equations through together, as one may be directly derived from the other by integration or differentiation. It is thought it may add interest to the case, if we have the two to compare, so that any differences that exist become more apparent.

After a very short time the last term of each of these equations, containing the arbitrary constant of integration becomes inappreciably small and may be neglected. Then it is seen that the current and charge are each harmonic functions of the time; but the current, instead of lagging behind the impressed E. M. F., as it did in the case where there was self-induction in the circuit, advances ahead of it by an angle whose tangent is $\dfrac{1}{C\,R\,\omega}$. When the capacity C is infinite (and there is no condenser in the circuit, as explained before) the tangent $\dfrac{1}{C\,R\,\omega}$ is zero, and the current is in phase with the E. M. F. When the condenser is short circuited so that the resistance is negligible, $\dfrac{1}{C\,R\,\omega}$ becomes very large and the angle of advance is nearly 90°.

The equation of the current than becomes

$$i = C\,E\,\omega \sin(\omega t + 90°) \tag{40}$$

and of charge

$$q = -Q \cos(\omega t + 90°) \tag{41}$$

The charge will always be a maximum when the current is zero and *vice versa*, as the cosine is a maximum when the sine is zero.

When the $\sin\left\{\omega t + \tan^{-1}\dfrac{1}{C\,R\,\omega}\right\}$ becomes unity the current has its maximum value I and,

$$I = \frac{E}{\sqrt{R^2 + \frac{1}{C^2\,\omega^2}}} \tag{42}$$

The radical $\sqrt{R^2 + \dfrac{1}{C^2\,\omega^2}}$ is the apparent resistance of the circuit, and corresponds to the radical $\sqrt{R^2 + L^2\,\omega^2}$, which has been called the "impendance" of the circuit, in the case where there is self induction and resistance only.

Case IV. Any Periodic Electromotive Force Which Is Not Harmonic.—If the impressed electromotive force is any periodic function whatsoever of the time, then—as was mentioned in the discussion of circuits containing self-induction—this E. M. F. may be expressed, according to a theorem due to Fourier, as the sum of terms of the form,

$$E \sin(b\,\omega\,t + \theta).$$

Thus,

$$e = \sum_{E,\,b,\,\theta} E \sin(b\,\omega\,t + \theta) \tag{43}$$

may represent any electromotive force whatsoever, where E, b and θ have n different values corresponding to n terms of the sum. As was previously shown in the case of self-induction, each term of the E. M. F. impressed gives rise to a corresponding term in the resultant current equation of the form

$$\frac{E}{\sqrt{R^2 + \frac{1}{C^2\,b^2\,\omega^2}}} \sin\left\{b\,\omega\,t + \theta - \tan^{-1}\frac{1}{C\,R\,b\,\omega}\right\}$$

where E, b and θ have values equal to their values in the corresponding term of the E. M. F. equation.

The expression for current then, when (43) is the impressed E. M. F. is,

$$i = \sum_{E,\,b,\,\theta} \frac{E}{\sqrt{R^2 + \frac{1}{C^2\,b^2\,\omega^2}}} \sin\left\{b\,\omega\,t + \theta + \tan^{-1}\frac{1}{C\,R\,b\,\omega}\right\} + c\,\varepsilon^{-\frac{t}{RC}} \tag{44}$$

This gives the general solution for the current in a simple circuit containing resistance and capacity, and any impressed E. M. F.

Efficiency of Transformers.—II.*

BY M. VON DOLIVO-DOBROWOLSKY.

Another question is, whether we could not by various modifications in the construction of a transformer diminish these iron losses. With a given quantity of iron, and having determined on a definite magnetic density for a given frequency, there will always be a certain fixed amount of energy required in the iron for alternating its magnetism. This energy is independent of the shape of the iron masses. The question then is how to shape or distribute these iron masses in order to best adapt them for the

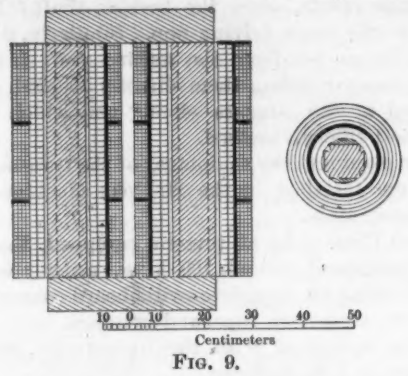


Fig. 9.

highest possible amount of transformed energy. The answer to the question thus put must be that the given amount of iron should be elongated, so to speak, in order to give the greatest possible amount of room for the copper windings. As a matter of fact with thick rings, the "window," or the opening for the coils, is disproportionately small. In extending the iron as a thin, large ring, one would not have to go so far, because in virtue of the larger periphery of the windings the output will not increase as rapidly as the weight of copper does, and the transformer might therefore become too expensive. At all events, it is to be recommended to give the iron such a form that as much copper as possible can be used, because the price of a transformer may safely become double the present average price if the cost of operation can thereby be materially reduced.

As an increase in the cross section is accompanied by a less rapidly increasing periphery, large transformers can be constructed even very materially better than smaller ones. We can, therefore, not warn too strongly against the American principle of putting a transformer in each of a number of small houses. The saving in the leads when large transformers are used is in no proportion to the increased cost of operation for small transformers. In systems of distribution where economy is of importance, one should use as few transformers as possible of less than five kilowatts. I believe that very soon the average size of transformers will become at least 20 kilowatts. In answer to the objection that very large transformers have not sufficient surface of radiation, and therefore become too hot, I would merely call attention as an illustration to the largest transformers ever built, namely, those of our installation in the Lauffen-Frankfort transmission; during the test of the commission of experts these transformers were run with current for days without increasing the temperature more than about 40 degrees C.; this was the case with those built by us as well as with those built by the Oerlikon company. As is well known, these transformers were built for 200 kilowatts.

I will now once more compare this method of looking at

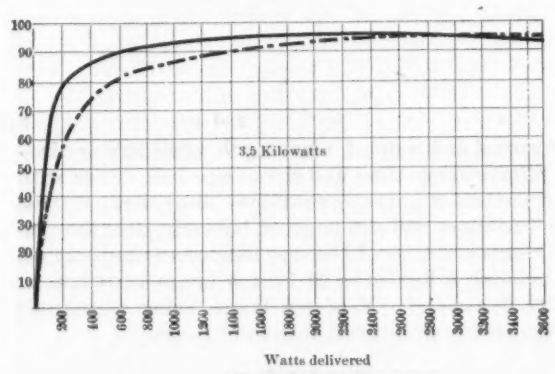


Fig. 10.

the transformer problem with the views formerly held quite universally.

1. Formerly: The magnetic resistance must have as low a resistance as possible; the iron should be short, thick and, as far as possible, without joints.

Now: Not much stress need be put on the magnetic resistance; joints may be employed without fear as they may be required for constructive reasons; sometimes such joints are even advantageous, in order to oppose the electrostatic capacity of the line; the iron core should be relatively thin and long in order to give much room for the copper.

2. Formerly: The copper should be inclosed as much as possible with iron, going even so far as to bury it in the iron in order to save copper.

Now: One should try to inclose the iron as much as possible with copper, in order more especially to save iron

3. Formerly: The transformer should be self-regulating, and for this reason the coils should have as little resistance as possible.

Now: One should not try to approach self-regulation, as

* For the first section of this paper see The Electrical World, May, 28, p. 369.

this is a delusion on account of the existing losses in the leads. The resistance of the transformer, provided it is not altogether too large, has little effect on the average economy; the latter may even become better if one increases the copper resistance in order to diminish the amount of iron.

In order to strengthen your belief in the possibilities of constructing good transformers which will have a good

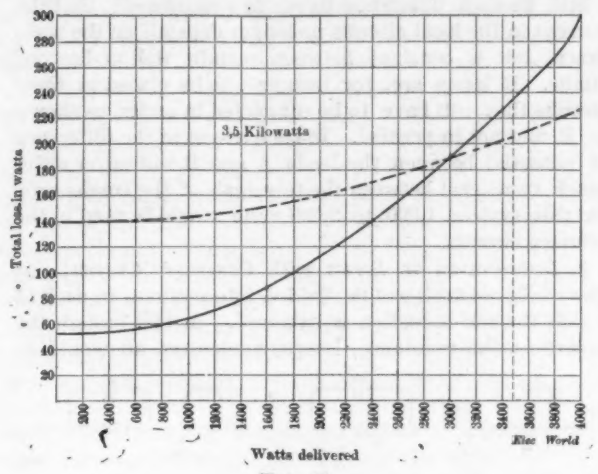


FIG. 11.

efficiency even at small loads, and, on the other hand, in order to illustrate my principles, I will give you some actual examples; they are all taken from the transformers built especially for distribution by the Alleg. Elektricitäts Gesellschaft.

Fig. 9 shows a transformer for 3.5 kilowatts at 80 alternations of magnetism (40 periods) and for reduction from 1,000 to 100 volts. The actual cross section of the iron, after deducting the insulation, is 42 square centimetres (6.5 square inches). The number of windings on the high voltage circuit is 3,600, and on the low voltage circuit 360. The diameter of the copper wire for the high tension coil is 2.3 millimetres (90.7 mils), equal to 4.1 square millimetres cross section; for the low tension winding, a wire of rectangular cross section 5 × 8 millimetres (197 × 315 mils); the cross-section, allowing for rounded corners, is 38 square millimetres. The resistance of the two coils is 9.0 and .064 ohms respectively when warm. From this the copper losses at full loads are a total of 5.3 per cent. The weight of copper in the transformer is 120 kilogrammes (264 pounds); the length of the iron core, 440 millimetres (17.3 inches), and of the yoke pieces, 350 millimetres (13.7 inches), are sufficient for the amount of copper given above, allowing ample room for insulation, end plates, etc. The weight of iron is about 50 kilogrammes (110 pounds). From the density of magnetism of say about 4,000 lines per square centimetre, and from the curve shown in Fig. 5,* which is for moderately good iron,

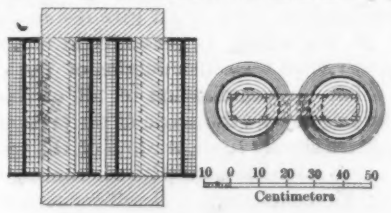


FIG. 12.

t follows that the energy on open circuit is about 50 watts, or 1.4 per cent. of the total output of the transformer. The curve of efficiency and that for the total losses are shown in Figs. 10 and 11 as a function of the output. The dotted curves represent the efficiency and losses for a transformer of the same size, proportioned according to the rules formerly used, namely, with only two per cent. copper losses and therefore four per cent. iron losses.

Fig. 12 shows a larger transformer for 20 kilowatts, with a ratio of 5,000 to 100 volts, and likewise for 80 alternations (40 pounds). The two low voltage coils have 76 windings of rectangular wire of 120 square millimetres. The high voltage coils have each 3,760 windings of two

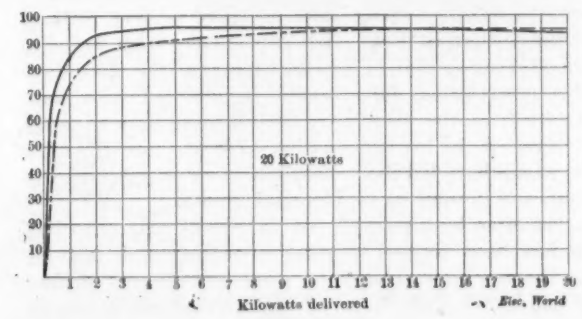


FIG. 13.

millimetre wire (78.74 mils), the cross section being 3.14 square millimetres. The total resistances are .0121 and 34 ohms respectively when warm. The copper losses at full load are about five per cent. The total weight of copper is about 330 kilogrammes (726 pounds). From the proportion of the iron, as shown in Fig. 12, its weight is about 160 kilogrammes (352 pounds); allowing for the insulation, it leaves a cross section of iron of 110 square centimetres (17 square inches). The magnetic density is in this case also about 4,000 lines per square centimetre. If in this case

* See THE ELECTRICAL WORLD, May 28, page 370.

also we use medium good iron, we will find a consumption on open circuit of about 160 watts, or only $\frac{5}{10}$ per cent. of the maximum output. Figs. 13 and 14 give the curves of the efficiency and for the losses. In this case also there are given, for the sake of comparison, the curves (dotted lines) for a typical transformer of the same output and voltage, in which the loss of voltage is two per cent. and the loss of energy on open circuit also two per cent. We notice for both sizes of transformers that with the maximum load the new transformers have a poorer efficiency than the older ones. But let us now deduce and compare the all-day losses and efficiency from the loss curves, Figs. 11 and 14, and from the daily consumption curve, Fig. 6.* If we assume as a maximum for the winter, 1,000 ampères multiplied by 100 volts, equal to 100 kilowatts, we will obtain the following table:

	Transformers of 3.5 kilowatts.		Transformers of 20 kilowatts.	
	Old.	New.	Old.	New.
In winter:				
Output of the transformers in kilowatt hours	573.0	573.0	573.0	573.0
Losses in kilowatt hours	103.5	54.7	55.4	38.2
All day efficiency	84.7%	91.25%	91.2%	93.7%
In summer:				
Output of transformers in kilowatt hours	181.0	180.0	186.0	186.0
Losses in kilowatt hours	96.6	36.3	48.6	20.7
All day efficiency	65.8%	83.8%	79.2%	90.0%

We see from this table not only the great advantage of the new method of proportioning transformers, but also that the losses are only very small when the transformers are used under unfavorable circumstances, as, for instance, in the failure to cut out superfluous transformers during the

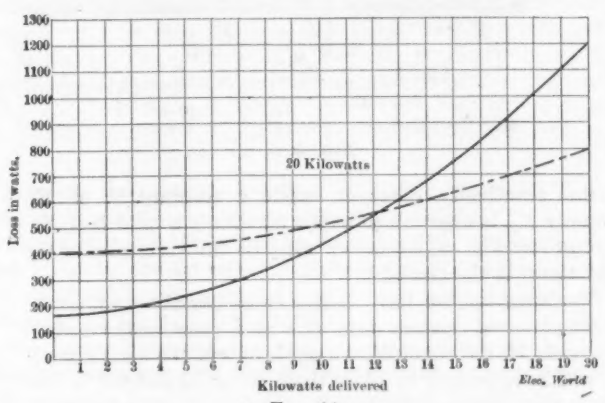


FIG. 14.

summer period, and allowing for no current for motors during the day. It evidently could not be said that is poor efficiency.

Three phase current transformers, of which Fig. 15 shows the latest form made by this company, are based on the same principles as the others, and what was said for the former therefore also applies to these.

I hope to have shown hereby that the widespread opinion that transformer installations are not paying because of the enormous losses during the day is without foundation. For the same reason the only remaining objections to the introduction of the rotary field current for long distance transmission and distribution are overcome.

[In the discussion which followed Mr. H. Gorges gave a somewhat lengthy mathematical dissertation, in which he deduced expressions for the cost of power wasted in the losses, and the interest on the capital invested in trans-

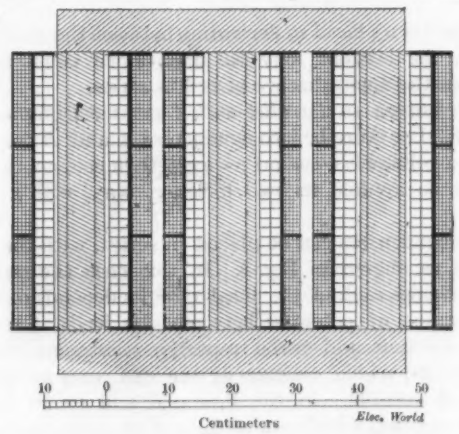


FIG. 15.

former, from which he then shows how the proportions may be deduced which will give the least possible total cost. For a complete record of this discussion see *Elektrotechnische Zeitschrift*, April 22, 1892, p. 225.—ED.]

Photography by the Aid of the Electric Spark.

The photographs of flying bullets, which have been exhibited by Mr. C. V. Boys, continue to attract the attention of the scientific world. As a piece of human ingenuity, they are of the greatest interest, and, moreover, are likely to throw considerable light upon the science of ballistics. In the best photographs taken by Mr. Boys, the outline of the bullet is perfectly sharp, although fired from the new magazine rifle giving it a velocity of 2,000 feet per second. Each projectile pushes in front of it an air ripple and is followed by a trail of vortices. Those who have previously attempted photography of this kind, employed the bullet itself for the purpose of closing the main circuit. Mr. Boys has found it of advantage to make the bullet start a subsidiary flash, which starts the main discharge. Mr. Boys has also found that sparks of comparatively moderate length and taken from *copper* terminals are by far the best for the purpose.

* See THE ELECTRICAL WORLD, May 28, p. 370.

An Electrical Cabinet.

The uses to which electricity can be put in the household are almost without number. There are so many little things

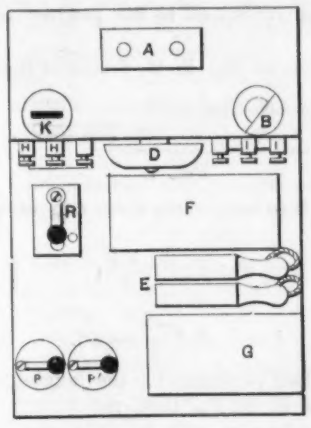


FIG. 1.—PLAN OF ELECTRICAL CABINET.

that can be easily accomplished by electrical means that would otherwise be impossible, or involve the employment of intricate and cumbersome mechanical apparatus. A very ingenious illustration of this is seen in the accompanying cuts of a cabinet devised by Mr. F. B. Widmayer, and now in use in his room at 217 West Twenty-second street, New York. The plan, elevation and sectional views clearly show its construction. It might properly be called an electrical medley.

On the top of the cabinet is an alarm clock connected to

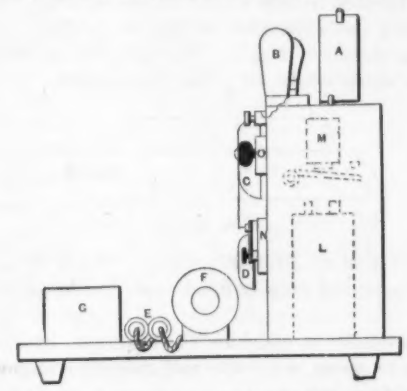


FIG. 2.—SIDE VIEW OF ELECTRICAL CABINET.

the two binding posts, *H H*, which rings a bell *C*. This circuit is controlled by a switch *P*. A three-candle power electric lamp, joined to the terminals *I I*, is provided with a reflector to throw the light on the face of the clock. *N* is a switch in the lamp circuit, and *O* a snap switch for the lamp.

An induction coil, *F*, provides for electrically lighting the gas, *K* being a switch in this circuit. There is a relay, *M*, which rings the bell *D* every time the gas is lighted, in which circuit is a switch *T*. The apparatus would not be

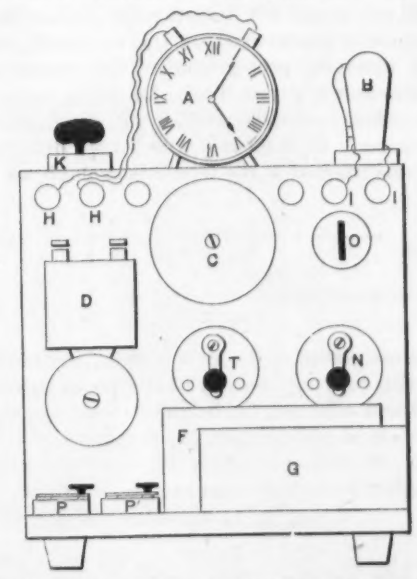


FIG. 3.—FRONT VIEW OF ELECTRICAL CABINET.

complete without a medical coil, and this is shown at *G*. The two handles are at *E*, and *P* is the controlling switch. Another switch, *R*, is to throw the batteries on to either the medical coil or alarm clock circuit. The cabinet contains four dry cells of the open circuit type, the medical coil requiring one, the alarm clock two, the gas lighter three, with another for the relay, and the incandescent lamp four. The combinations are accomplished by the variou switches.

This is a case of "much in little," and will be of interest to those who delight in such ingenious contrivances.

Systems of Alternating Current Distribution with the Aid of Condensers.

BY W. CAMILLE RECKNIEWSKI.*

One of the greatest obstacles to the development of alternating currents lies, as is well known, in the phenomena of self-induction of the apparatus used with such currents. The objectionable features of self-induction are of two kinds: first, the self-induction of an apparatus prevents such apparatus from allowing a current to pass, which would correspond to the E. M. F. at the terminals and to its ohmic resistance; secondly, it produces a lagging of phase between the current and the E. M. F. such that the energy transmitted by the current generated by a given E. M. F. does not correspond to the product of these tw factors.

If the variations of the E. M. F. and of the current are

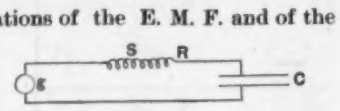


FIG. 1.

harmonic, that is to say, when they can be expressed by the formula

$$e = E_0 \sin \frac{\pi t}{T}$$

and

$$i = I_0 \sin\left(\frac{\pi t}{T} - \varphi\right),$$

in which T is a half period and φ the lagging between the current and the E. M. F., then the power transmitted through the conductors will be expressed by the well known formula,

$$\text{power} = \frac{E_0 I_0}{2} \cos \varphi.$$

It is well known that one can balance the E. M. F. of self-induction by using condensers, and thereby annul the lagging of phase between the current and the E. M. F. Condensers can be employed for this purpose in different ways permitting one to use systems of distribution different in, many points from existing systems; it was therefore thought interesting to give a general summary of some of these systems of automatic distribution with the aid of condensers.

They can be used in two ways: In series with the self-induction and the apparatus as shown in Fig. 1, and in derivation as shown in Fig. 2. The theoretical treatment of these two cases could be made analytically, or by the

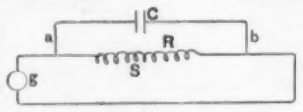


FIG. 2.

geometric method of Prof. Blakesley. We will not give this theory here, but merely limit ourselves to some of the results.

To begin with, let us consider the first case, in which the condenser is in series with the self-induction and the apparatus (Fig. 1).

Let $e = E_0 \sin \frac{\pi t}{T}$ the E. M. F. of the generator, g.

R = the resistance of the circuit.

S = the self-induction.

The capacity of the condenser which will balance this self-induction is given by the formula

$$C \quad \frac{T^2}{\pi^2 S}$$

Under these conditions the current will be equal to

$$\frac{e}{R} = \frac{E_0}{R} \sin \frac{\pi t}{T} = I_0 \sin \frac{\pi t}{T}$$

as there will not be any self-induction; by maintaining the same difference of potential E_0 at the terminals, the cur rent will be inversely proportional to the resistance, that is, if the condenser is adjusted once for all to balance the self-induction for one resistance R, it will also balance it for other resistances. If therefore a constant difference of potential is maintained at the terminals a and b (see Fig. 3)

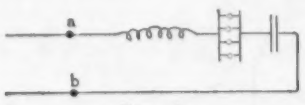


FIG. 3.

and if lamps are placed in the local circuit, they must be in parallel: in that case any number of lamps can be switched on or off without affecting the brightness of the others.

The difference of potential at the terminals of the condenser when equilibrium is obtained is equal to the E. M. F. of self-induction, and can be expressed by the formula

$$\frac{S I_0 \pi}{T},$$

In the larger number of the practical cases, in which electromagnets are in circuit, this E. M. F. of self-induction is much larger than the effective E. M. F., that is to say, than the current multiplied by the resistance, $E_1 = R I_0$. In the course of the present article we will consider only this case, to which one can readily reduce all the others by introducing into the circuit additional self-induction.

Let us consider now the second case where the condenser is in derivation with the circuit having self-induction, as shown in Fig. 2. In this case one can, by properly proportioning the capacity of the condenser, redress the phase of the current in the external circuit, and therefore in the generator. In this disposition the current in the external circuit can be much smaller than the current in the local circuit. The difference of potential at the terminals of the local circuit, on the other hand, is much larger than the effective E. M. F. of the local circuit. The E. M. F. at the terminals of the local circuit, a and b, is then equal to that of the condenser, that is,

$$\frac{S I_0 \pi}{T}$$

which is, in all the cases that we will consider, much

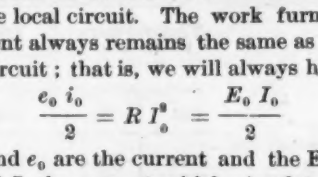


FIG. 4.

larger, sometimes more than 100 times larger, than the E. M. F. of the local circuit. The work furnished by the exterior current always remains the same as that absorbed in the local circuit; that is, we will always have

$$\frac{e_0 i_0}{2} = R I_0^2 = \frac{E_0 I_0}{2}$$

in which i_0 and e_0 are the current and the E. M. F. of the generator and I_0 the current which circulates through the local circuit E_0, the effective E. M. F. In this case the condenser plays the part of a transformer, while it increases in great proportions the local current. This is why Prof. Blakesley calls the condenser used in this way a "condenser transformer."

It could be proven that while the E. M. Fs. of self-induction are large in proportion to the effective E. M. Fs. which is, as we have already stated, the case which interests us chiefly at present, the current I_0 in the local circuit re-

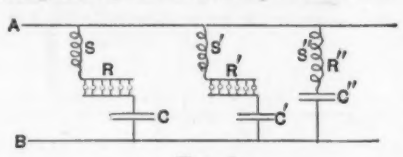


FIG. 5.

mains practically constant, while a constant E. M. F., namely E_0, is maintained at the terminals a and b of the circuit (see Fig. 4), whatever may be the variations of the resistance in the circuit.*

Summing up, we have here a transformation of a constant potential system into one of a practically constant current. If, for example, we put lamps in the local circuit, it will be necessary to place them in series and not in parallel; they can then be turned on or off at will without affecting the light of the others (Fig. 4).

If, on the other hand, the exterior current i_0 is maintained constant, the current I_0 of the local circuit will vary in inverse proportion with the resistance of the circuit, and the lamps must then be placed in parallel. We would then have a transformation of a constant current into a practically constant potential system.

We will now pass to the study of systems of distribution, properly so-called. One can divide such systems into classes: One in which a constant difference of potential between the leads is maintained (the apparatus in the local

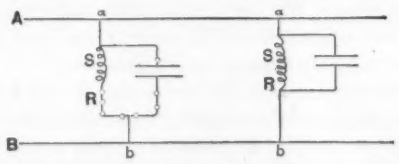


FIG. 6.

circuits are then placed in derivation between the leads; or secondly, the current may be maintained constant, in which case the apparatus are placed in series.

1. *Distribution in Parallel with Constant Difference of Potential.*—Let there be two conductors A and B between which the voltage is constant; we can then connect the apparatus to be applied in two different ways with a condenser.

(a) The condensers can be placed in series, with the self-induction as shown in Fig. 5. In this case the current which traverses each of the local circuits depends only on the difference of potential between the leads A and B, which is constant, and on the respective resistances of each of the circuits, which resistances one can vary at will in these local circuits. In the figure, R and R' are lamps placed in parallel, which can be lighted or extinguished at will. In this system of distribution the current in one line A B is equal to the sum of the currents in the apparatus or local currents, while the difference of potential is equal to the effective E. M. F. of the circuits; that is, if the apparatus are, as usual, designed for 100 volts, the difference of

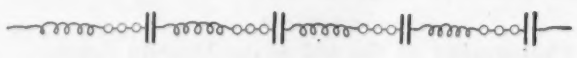


FIG. 7.

potential between the leads will also be 100 volts. The leads can then figure as conductors for the secondary distribution of the present systems for alternating currents. It may be necessary to add here that the difference of potential between the terminals of the condenser can be much larger than the E. M. F. of 100 volts at the leads.

(b) The condensers can also be placed parallel to the apparatus, as shown in Fig. 6. In this case also the lagging of the phase can be avoided by properly proportioning these condensers. But for the same disposition of the apparatus as in the preceding case, the difference of potential between the points a and b, that is to say, between the leads, will be much larger than the effective E. M. F. in this apparatus, and the current in these conductors will be much smaller than the sum of currents in the local circuits. In this case the condensers also play the part of transformers.

Still another difference exists in this, namely, that the current in the local circuits no longer depends on the resistance, but is constant between certain well understood limits. If lamps are, for instance, to be placed in these circuits they will have to be connected in series, as shown by R, and not in parallel. In such a system the difference of potential between the leads A and B will never differ much from that between the terminals of the condensers. In this system 1,000 to 2,000 volts would be used in the primary circuits.

2. *Distribution in Series with Constant Current.*—(c) The whole network can be divided into sections, in each of which the self-induction is balanced. In this system the apparatus, the resistance, lamps, condensers, all would be

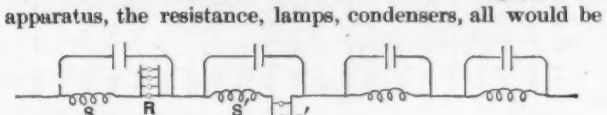


FIG. 8.

in series. One could evidently balance the self-induction of the entire circuit by a single condenser, but this might lead to the production of E. M. Fs. which are excessively high at the terminals of the condenser and between different parts of the circuit and the earth. But by balancing the self-induction of the different sections with condensers placed as indicated in Fig. 7, one can prevent the generation of too high differences of potential in any part, whether between the terminals of the condenser or between the different parts of the circuit and the earth. As will be evident from the figure, if the current in the main line is maintained constant the lamps can be turned on or off at will.

(d) The apparatus may be placed in series, and the condensers in parallel, so as to form a series of local circuits in which the self-induction is balanced by the condensers, as shown in Fig. 8. In this case it is the effective E. M. F. which will remain constant in each of the local circuits; in connecting lamps in such circuits they must be placed in parallel, as shown in the figure.

We do not wish to discuss here the advantages, the objections, and the possible future of each of these systems of distribution; all such questions depend, first of all, on the price of the condensers necessary in each case; furthermore, the technical study of condensers is not sufficiently advanced to enable one to draw indisputable conclusions from which predictions could be made.

Still another question which could give rise to difficulties is the high E. M. Fs. which are generated at the terminals of the condensers when the self-induction of the circuit is considerable; but an examination of all of these questions would lead us beyond the scope of the present article, in which we desire simply to show some of the systems of distribution which could be used with alternating currents in connection with condensers and self-induction. These systems have been mentioned more or less in detail in the literature of the near past, but we thought it would be of use to give a general summary of them here.

NEW BOOK.

ELECTRICITY AND MAGNETISM, by James Clerk Maxwell. Third edition, edited by J. J. Thomson. Clarendon Press, Oxford, 1892. Two vols. Price, $8.

The first edition of this elaborate treatise was published in 1873, and the second, edited by W. D. Niven, in 1881. In getting out the third edition the publishers, in order to make the book as useful as possible, have had it thoroughly revised and such explanatory matter inserted as it was thought would add to the value of the work. Very little, if any, change is found necessary to bring Professor Maxwell's writings up to date, as there is very little of the time element in them. His papers have been found to be ahead of rather than behind the times, and the more thoroughly investigators have become acquainted with Maxwell's writings, the more have they realized that he must have traveled, in his imagination at least, over the same paths which have led them nearly a score of years later to similar, and in some cases, identical results.

As has often been pointed out in recent years, much of what has been termed original investigation is nothing more than an interpretation of what any diligent student may find between the lines of Maxwell's classical papers. Students have been too often frightened away from a perusal of Maxwell's two volumes by the reputation which they have in some way acquired of being extremely difficult reading and beyond the comprehension of the ordinary student. The average reader will be surprised to find, however, that many parts of Maxwell's writings are as easy and extremely interesting reading as other parts are difficult.

It was the intention of the editor in preparing this third edition to give in foot notes some account of the advances since the publication of the first edition, partly because all recent investigations have tended to confirm in the most remarkable way the views advanced by Maxwell. This was found to be inconvenient, however, and the editor de-

* Translated for THE ELECTRICAL WORLD from *L'Electricien*.

* Regarding this subject see the able article of M. P. Boucherot, Nos. 15, 16 and 17 of *L'Electricien*, 2d series.

cided to throw the notes into a slightly more consecutive form, and to publish them separately as a supplementary volume, which, it is announced, will appear in a few months.

An Electro-Mechanical Vacuum Pump.

Although numerous attempts have been made to displace the mercury pump from the position it has so long occupied in the manufacture of incandescent lamps, none of them have been completely successful. Mechanical pumps have been very useful in producing a partial vacuum, but it has almost universally been found necessary to supplement their work with the mercurial pump. The expense, however, and especially the time consumed by this process, is considerable, and a mechanical pump not open to the objections which are now urged against them has anxiously been looked for. Mr. Allen A. Dittmar and Mr. Hugo Falkenhausen claim that they have solved the problem in their new electro-mechanical vacuum pump, which is here illustrated. In Fig. 1 is seen an excellent representation of the pump and exhausting apparatus.

Two cylinders 6 inches in diameter are mounted vertically upon a crank chamber, and the pistons connected to the two opposite cranks by short connecting rods. The upper ends of the pump cylinders are closed by casings, the flanges of the two being bolted securely together. Each of these casings is divided into two compartments, one of which, *H H*, is connected by a suction pipe to the vessel to be evacuated and the other, H^1 H^1, by a discharge pipe to the trap cylinder *J*, which is mounted on the base chamber and communicates with it as well as the external air. The crank chamber, pump cylinders and trap cylinder are all filled with oil, as is usual in air pumps.

The feature of the pump is the valve mechanism, which is best shown in Fig. 2. In the casing which closes the end of each cylinder are two valves, one in each chamber, the one tapering upward the other downward. The extension of these valves forms the cores of two solenoids, which are excited by a current from some external source—in this case a United States dynamo, and controlled by a commutator placed on the crank shaft. This commutator consists of two semi-annular rings each lying in a different periphery, and both simultaneously fed by a brush *o*, which presses alternately upon the two sections. There are also two sets of brushes, *m m'* and *n n'*, which feed the solenoids. The action of the valves can be easily understood by reference to Fig. 2, which, however, shows the two solenoids in a plane at right angles to that which they really occupy in the present pump. The piston in the right hand cylinder has just completed its stroke; at the instant it starts upward the brushes *n n'* come in contact with the segments *l* l^1 and energize the solenoids K^1 K^2. The cores *H* H^1 will be drawn up, closing the valve which leads to the vessel to be exhausted and opening that through which the air is discharged into the chamber *J*. When the piston reaches the other end of its stroke the brushes break contact, the core *H* is forced down by the spring and closes its valve, while the core H^1 drops and opens the other. At the same time the brushes *m* m^1 make contact, the two solenoids on the left-hand cylinder are alternately excited, and precisely the same action takes place there. In this way the opening or closing of the respective valves is performed simultaneously with the alternating up and down strokes of the pistons in the pump cylinders. The controlling mechanism is entirely automatic and very simple.

One of the greatest difficulties in the construction of the mechanical pump is that of securing perfectly airtight joints. In this machine entirely satisfactory results have been obtained by carefully milling the faces, inserting a layer of thin paper heavily coated with asphalt varnish and screwing down the whole tightly. Fig. 1 also shows the connections to the lamps, which are temporarily made with gas piping and rubber tubing, all the joints being thickly painted with varnish.

The pump here illustrated is not the first one that has been built. The first one was constructed at one of the largest factories in the country, and did good service.

Since then many new features have been added and improvements made by Messrs. A. S. and Chas. F. Reinman, the former late superintendent of the Sawyer-Mann Electric Company, the latter in the lamp business for the past fifteen years, and both connected with this enterprise.

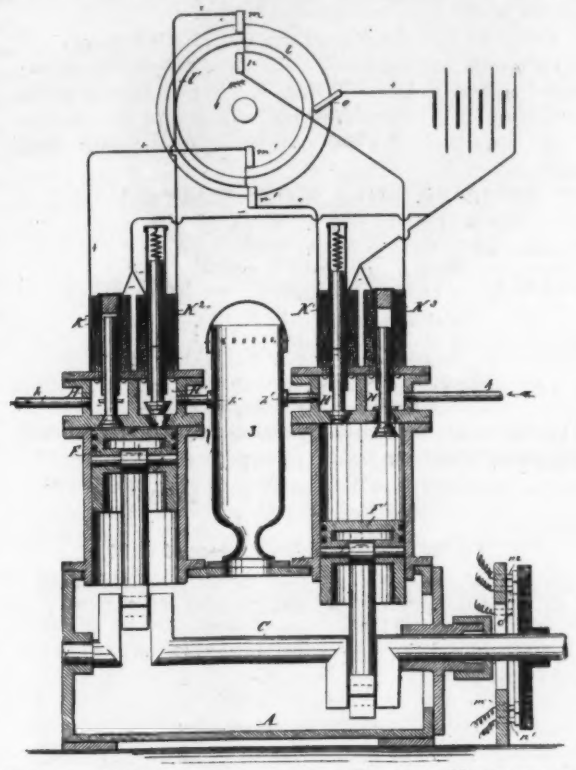


FIG. 2.—MECHANISM OF THE ELECTRO-MECHANICAL VACUUM PUMP.

Lamps exhausted by this process have burned between 600 and 700 hours and are in as good condition, it is said, as any on which the best mercury pumps were used which have burned the same length of time.

As the construction of the pump is very simple, it is claimed that the first cost can be made exceedingly low, and as to repairs, they will hardly be necessary, except an occasional packing ring, which is required in all pumps or engines. This process, it is claimed, will materially reduce the price of incandescent lamps in the near future.

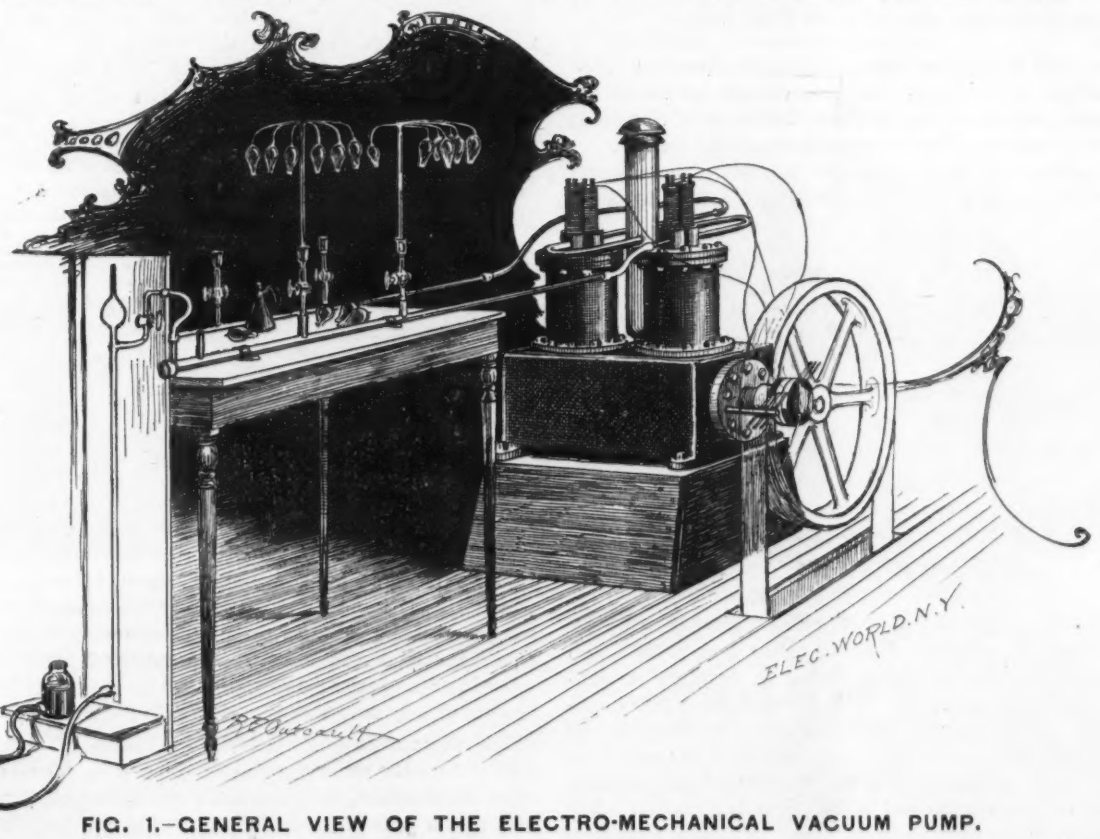


FIG. 1.—GENERAL VIEW OF THE ELECTRO-MECHANICAL VACUUM PUMP.

Electro-Metallurgy.—V.*

BY F. M. F. CAZIN.

Returning to the subject of general electrolytic calculation, it should be unmistakably stated that the method for calculating the electromotive force required in electrolytic deposition of metals, as it is illustrated in the two foregoing examples, answers its purpose fully, as long as the hypotheses are in no case taken from cases assumed to be analogous, that is, as long as in each special given case an experimental value, obtained in an absolutely equal or identical case, is made the basis of calculation and no other.

And it should not be ignored that even *these values*, as they are constructed by the multiplication of the caloric experimental value *ht* (1) by *AWP. eP*, that is of the caloric effect relating to one weight unit of the positive matter combining by atomic weight of such matter entering any compound, as is under consideration, *are constructive and comparative values only.*

Neither the values for *Ht* nor the value of 44,759 per volt are in any way claimed to be true equivalents of energy, but it is claimed that they stand in such a relation to one another that existing error is compensated in their simultaneous use in the same equations, a coefficient of incorrectness, so far unknown, affecting dividend and divisor equally.

To determine a true, correct and positive equivalent for electric energy as against caloric values will become possible only when further discussion will have brought clearness into other matters bearing directly thereon, and for which I have to solicit further attention.

The following values of the E. M. F. required in the precipitation of the metal from the compounds named have been calculated by the method as stated:

For sulphate of zinc, 2.37 volts; ferro-sulphate, 2.08; ferri-sulphate, 4.82; sulphate of copper, 1.25; nitrate of copper, 1.17; nitrate of silver, 0.37; nitrate of lead, 1.56; acetate of lead, 1.46; ferro-chloride, 2.23; ferri-chloride, 5.70; cupri-chloride, 1.42; gold chloride, 0.59; mercury chloride, 1.33; dichloride of tin, 1.81; tetra-chloride of tin, 3.51; cupri-sulphide (CuS), 0.41.

These values essentially represent the electric pressure required and indispensable for bringing about the disunion of the compounds mentioned. Any lower electric pressure would not produce such disunion. This requirement in electric quality is entirely independent of another and different coefficient *C* in electric energy, on which depends the quantity of metal disengaged.

If we thus possess an empirical method of calculating the requirement in electric pressure in order to bring about a desired electrolytic quality of action, we are closely approaching the possibility of a theoretical or mathematical method for such calculation on the basis of known general natural laws.

And with regard to this it may be stated that the conditional caloric effect of oxygenation is measured in all cases where the effect is not modified by a change in volume from the sum of components to more or less than the same in the compound, by 3,030 gramme-calories per kilogramme of oxygen.

By taking advantage of this fact (compare 9th law, page 310, 1st column) we may arrive at an approximate value for the electric pressure required for the performance of a stated electrolytic disunion in those cases where no empirical value is known for the conditional caloric effect (*Ht*) to chemical union and electrolytic disunion, as the preceding table shows them.*

In order to arrive at this approximate value we have to make use of the following equation:

$$\tfrac{1}{2} \times R_{(2)} = \frac{O}{2} \times \frac{3{,}030}{44.759} = \frac{15.96}{2} \times \frac{3{,}030}{44{,}759} = 0.54 \text{ volts},$$

showing a requirement of 0.54 volt per one-half equivalent of oxygen to be disengaged from its compound.

If this equation, as it does, can aid in finding the said value, when it relates to compounds, in which the negative element consists of oxygen, the question relating to other negative elements will be discussed further on.

Although there can be no intention on my part to provide at this place for all the conclusive evidence in proof of the ninth law, on which the preceding equation exclusively rests, it is only proper that I should show as concisely as possible, the method in which evidence and proof of this law have been obtained. To do so is of advantage, as it will furnish an opportunity to show and describe an apparatus which of necessity must make a part of an electro-metallurgical outfit, namely, the apparatus in which the value for $ht_{(1)}$, $h_{(1)}$, or *Ht* have been experimentally established.

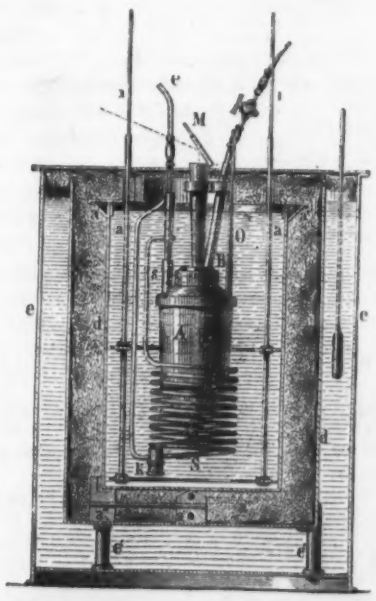


FIG. 4.—FAVRE AND SILBERMANN'S CALORIMETER.

The combustion of carbon (C) to carbon dioxide (CO_2) is one of the rare cases, as it has been proved by the apparatus also shown as constructed by Hoffman and made effective by the use of an electric spark, where no change of volume takes place between the sum of the components and the compound. The caloric effects of such combustion have also been measured by the use of the apparatus already mentioned and here shown as Favre and Silber-

* For the last section of this article see THE ELECTRICAL WORLD of May 28, 1892, p. 368.

* For interpretation of all symbols see the Table of Symbols below, without reference to their previous use.

mann constructed for such measurement of caloric effects. The combustion chamber *A* is made of a gilt copper sheet. The oxygen (negative matter) is introduced by the tube *O* from a gas meter filled with such oxygen. The tube *B* is used to introduce such positive matter as is in gaseous form, it being closed when not thus used. The gaseous products of combustion pass out of *sSe*, but when there are no such results, this tube also remains closed at *e*. Through the cover passes the tube *M A*, which is covered by a piece of heavy plate glass on which a mirror rests. This is so set that the process of combustion inside of the calorimeter may be observed. This entire arrangement is fastened to and suspended from the cover of the calorimeter, *aa*, and the vessel *d* separates the calorimeter from the water which fills the vessel *e*.

The calorimeter proper *aa* is a cylindrical vessel 0.2 m. high and 0.12 m. wide, silvered and polished outside to lessen the emission of heat. A cover of the same material has, besides the larger central perforation, the necessary openings for the thermometer and the rods *ii* of a stirrer. Through the larger central opening, which is provided with an upright collar, the above named tubes are passed. The calorimeter *aa* is supported inside of the cylindrical vessel *d*, also of sheet copper, by cork supports, the space between *d* and *a* being as 0.02 m. laterally, and 0.025 m. below, this space being nearly filled with the finest bird's skin, which is fastened to the outer cylinder without touching the inner one. The water space is laterally 0.025 wide and below 0.035 high.

This apparatus is here described, because aside from all electric measuring instruments it makes a necessary complement to an electro-metallurgical outfit as offering the means for testing the caloric effect of reactions not given in any of the tables of experimental values now known.

In this apparatus one unit of weight of positive matter is commonly caused to enter the compound, and the values as used in the preceding table for $Ht = ht\,(_1) \times AWP \times cP$ are developed from caloric value $ht\,(_1)$ as obtained in the apparatus by multiplication with the atomic weight of such positive matter as is present in the compound.

And again, from the values experimentally established for one weight unit of positive matter $ht\,(_1)$ the caloric effect of one weight unit of negative matter ht has been calculated by the equations:

$$ht = h\,(_1) \times \frac{A\,W\,P \times c\,P}{A\,W\,N \times c\,N} = \frac{H\,t}{A\,W\,N \times c\,N}$$

TABLE OF SYMBOLS.

$A\,W\,N$ is the atomic weight of negative matter;

$c\,N$, the coefficient to the negative element;

$A\,W\,P$, the atomic weight of positive matter;

$c\,P$, the coefficient to the positive element;

$H\,t$, the comparative caloric effect of chemical reaction, when the compound is formed, and inversely of electrolytic disunion by $Ht = ht\,(_1) \times AWP \times cP = ht \times AWN \times cN$;

$H\,t\,(_1)$, the caloric effect of reaction in forming the compound and relating to one weight unit of the compound: and by $Ht\,(_1) = \frac{ht\,(1)}{AWP} \times cP$;

$h\,t$, the caloric effect of chemical reaction in forming the compound and relating to one weight-unit of the negative matter, by $ht = \frac{ht\,(1) \times AWP \times cP}{AWN \times cN} = \frac{Ht}{AWN \times cN}$;

$ht\,(_1)$ the caloric effect of chemical reaction in forming the compound relating to one weight-unit of the positive matter (metal) by $ht\,(_1) = Ht \,/\, AWP \,.\, cP = ht \times \frac{AWN \times cN}{AWP \times cP}$;

$R\,(_1)$ the electric energy expressed in volts, that is conditional to bringing about a specific electrolytic action by

$$R\,(_1) = \frac{ht\,(_1) \times AWP \times cP}{44.759};$$

R (2) the electric energy expressed in volts, that is equivalent to the setting free of one weight-unit of negative matter by $\frac{Ht}{44.759} \times \frac{1}{AWN \times cN}$.

This equation applied to CO_2, in the formation of which no volumetric change takes place (compare Hoffmann apparatus) will read as follows:

$$h\,t = 8080 \times \frac{11.97}{2 \times 15.96} = 8080 \times \tfrac{3}{8} = 3030.$$

The disengagement of O_2 from C will in accordance therewith require *per weight unit of compound* $\frac{H\,t}{44.759}$ volts, both relating to the same weight unit; this is in the case under consideration.

$$Ht\,(_1) = R\,(_1) = \frac{H\,t}{44.75} = \frac{8.080}{44.759} \times 11.97 = 2.16 \text{ volt}$$

per unit of compound; and on the other hand, such requirement *per unit of oxygen* must be as

$$ht = R\,(_2) = \frac{1}{44.759} \times H\,t \times \frac{1}{A\,W\,N}$$

or by

$$H\,t = h\,t \times A\,\,W\,N \times cN,$$

as

$$R\,(_2) = \frac{1}{44.75} \times ht \times cN.$$

It is this latter value $R\,(_2)$ per unit of negative matter, which is the main object of consideration and comparison, because it is the quantity of negative matter, by which it is claimed that the caloric effect of chemical reaction is truly, correctly and positively measured under the sole condition of unmodified space occupied. And it is also claimed as a necessary conclusion, that inversely the electric energy, which is conditional to electrolytic action is also measured by the quantity of negative matter disengaged in such action.

For all cases when, as in the case quoted, no volumetric change occurs between components and compound, the same value of 3,030 calories would be valid per weight unit of oxygen, and to establish the value for $H\,t$ in all *these* cases, we would have to use the equation

$$Ht = ht\,(_1) \times AWP \times cP = 3{,}030 \times AWP \times cP.$$

If, therefore, we were to assume the condition of unchanged volume to be fulfilled, as it is very nearly so in the two cases of $C_2\,H_4$ combining with O_4, and of Pb combining with O, in both of which cases, notwithstanding their value, for

(a) $ht\,(_1)$ is for $C_2O_4H_4O_2 = 11.858$, and

(b) $ht\,(_1)$ for Pb only $= 0.266$,

their value for $ht\,(_1)$ is $= 3.458$.

because by $ht = ht\,(_1) \times \frac{A\,W\,P}{A\,W\,N} \times \frac{cP}{cN}$ we have

(a) $h\,t = 11.858 \times \frac{27.94}{95.76} = 3.458$

(b) $h\,t = 0.266 \times \frac{206.40}{15.96} = 3.458$

If the value for ht were not known it might be established on the stated condition by

(a) $ht\,(_1) = \begin{cases} \frac{3.030 \times A\,W\,N}{A\,W\,P} \times \frac{cN}{cP} \times = 3.030\,\frac{95.76}{27.94} \\ 3.030 \times \frac{24}{7} = 10.388 \text{ in place of } 11.85 \end{cases}$

(b) $ht\,(_1) = 3.030 \times \frac{15.96}{206.40} = 0.233$ in place of 0.266.

and by $Ht = ht\,(_1) \times WAP \times cP$ this value may be ascertained as

(a) $10.383 \times 27.94 = 290.240 = Ht$

(b) $0.233 \times 206.4 = 48.091\ Ht$ in place of 54.9.

We thus possess a method for a theoretical and mathematical valuation of the effect $H\,t$ and of the value for elec-

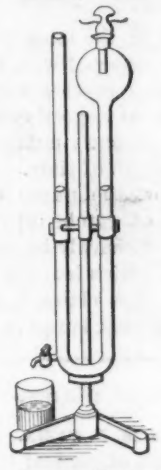


FIG. 2.—HOFFMANN'S APPARATUS FOR THE COMBUSTION OF CARRON, ETC., AND FOR THE MEASUREMENT OF VOLUMETRIC CHANGES IN SUCH COMBUSTION.

tric pressure depending upon electrolytic disunion. And the method would bring absolutely correct instead of approximate values, if the influence of change of volume as between components and compound were fully known.

The equation for required electric pressure in disengaging one weight unit of negative matter is then known to be as follows:

$$R\,(_2) = \frac{H\,t}{44.759} \times \frac{1}{A\,W\,N \times c\,N} \text{ volts.}$$

Therefore, the equation for total conditional electric pressure required in any electrolytic action, in which oxygen is disengaged, and for which the experimental value $H\,t$ is not known, and where no volumetric modification takes place, would bring correct results in using the ninth law quoted on page 310, first column, in the following form:

$$R\,(_1) = \frac{1}{44.759} \times ht\,(_1) \times A\,W\,P \times c\,P = \frac{3030}{44.759} \times$$

$$A\,W\,P \times c\,P \text{ volts} = \frac{Ht}{44.759} \text{ volts.}$$

Following out the two exemplifications already used in this discussion, namely, those of PbO and COHO, the variation by volumetric change being in both cases identical, namely, as expressed by $3.458 - 3.030 = 0.428$ calories per gm. of oxygen; they also serve to illustrate the fact that electric energy absolutely required for effecting electrolysis is proportional to the quantity of the negative element oxygen disengaged in the electrolytic action. We have these cases:

(a) $R\,(_1) = 27.94\,\frac{11.858}{44.759} = 7.402 = 12 \times 0.617$ volts.

(b) $R\,(_1) = 206.4\,\frac{0.266}{44.759} = 1.226 = 2 \times 0.617$ volts.

(c) $R\,(_1) = 11.97\,\frac{8.080}{44.759} = 2.161 = 2 \times 0.54$ volts.

the values $R\,(_1)$ standing in approximately the same relation to one another as the values $\frac{A\,W\,N \times c\,N}{A\,W\,P \times c\,P}$ applying to the three cases do; this is as 24:7 : : 1:13 : : 8:3, the discrepancy being due to modification of space occupied as between components and compound.

And yet the question of comparative heat effect of forming the compound and inversely of the electric energy required to disengage the elements of the compounds into their groups or individualities, as between those containing oxygen and those containing other negative matter, such as chlorine or sulphur, has to be discussed.

This question forms the bridge from the discussion of electric pressure required to secure electrolytic action and the discussion of quantity of matter disengaged.

The absolute or total heat effect of chemical reaction is inversely proportional for the same weight unit of negative matter to the atomic equivalent (chemically) of the negative matter.

This being a necessary result of Faraday's law, when it is properly read and interpreted, we may here dispense with its discussion, as this will be more fully taken up in the next sections.

The general laws relating to oxygen relate to the other negative matters also. The special caloric values relating to them have as yet not been so thoroughly investigated as those relating to oxygen have been.

6. QUANTITY OF ELECTROLYTIC ACTION AND OF METAL DISENGAGED IN SUCH ACTION.

The second of Faraday's laws: "The same quantity of electromotive force, which in a given time decomposes a measured quantity of water, decomposes in the same time an equivalent quantity to that of the water (decomposed) of any other compound" established the fact of a constant relation between E. M. F. employed and matter decomposed, but it left the positive measurement of such E. M. F. by either the one or the other of the matters decomposed unsettled, while composition at different relative proportions of the same matters made such distinction appear as of final importance. But Faraday's law is not only not contradictory to the law of measurement of E. M. F. by the negative matter set free, but, on the contrary, serves well as corroboration in part because what matter is equivalent with 1 hydrogen in electrolytic deposition must relate and does relate to the negative equivalents in the compound precisely as H_2 relates to 1 oxygen in their compound H_2O or as 1 H to $\frac{O}{2}$.

And better evidence yet may be offered for the existence of the natural law as stated. As a means for measurement of electric energy, or more specifically of the area of electric action in any expression of electric energy or of the ampères, assumed as units of such area, the two celebrated electricians, Kohlrausch and Siemens, established the proportionate quantities of silver, copper and hydrogen, which are disunited from such of their compounds, as they experimented with by a current assumed as one ampère per second.

If both the newly stated law, "that electric energy required in electrolysis is proportionate to the quantity of the negative element set free," and Faraday's second law, "that equivalent electric energy disunites equivalent proportionate quantities of other compounds and elements to the quantities of H_2 and O disunited in the decomposition of water," are true and correct, then there must be a proportional relation between the "quantities found by Kohlrausch and Siemens," and the "values of chemical equivalents" for the same chemical elements.

That this be indeed so, as found to be necessary in corroboration of the law newly stated (by me), is plainly shown by a combination of the different values.

Metal electrolytically disunited.	Equiv. of these metals with oxygen in their compounds.	Equivalent of metal corresponding with $\frac{H_2}{2} = \frac{1.000}{2}$	Prop'r-tionate or equiv-alent quantities.	Quantity in milligrms. of metal disunited per ampère second according to	
				Kohlrausch.	Siemens.
Silver, Ag...	$Ag_2\,O$	$A_1 = 1 \times 107.6 =$	1.076	1.1290	1.1000
Copper, Cu..	Cu O	$Cu\frac{1}{2} = \frac{1}{2} \times 63.2 =$	0.316	0.3320	0.3223
Hydr'g'n, H.	$H\,O_2$	$H_1 = 1 \times 1.0 =$	0.010	0.0105	0.0102

Although these values of necessity are proportional, their almost perfect identity or close similarity of valuesfor (a) chemical equivalents proportionate to quantity of oxygen, and (b) quantities of metal disunited per ampère second would appear as phenomenal, because between atomic weights, and time there is no conceivable connection. But this excessive similarity is only the result of both the equivalent for hydrogen and for quantity of hydrogen disunited per ampère second appear as the unit "1," or very approximately it.

The discrepancies between the quantities of metal dissolved from the same quantity of oxygen by actual experiment (Kohlrausch, Siemens) and those calculable by equiv-alents on a unit of $\frac{1}{2}$ oxygen indicate the necessity only of revising either these experimental quantities or even the values for atomic weights.

The Street Railway Gazette Under its New Management.

The *Street Railway Gazette* appears this week in a new form and under new management. The editor, Mr. M. J. Sullivan, has secured the control of the paper, and hereafter will be the editor and publisher: Mr. Chas. Desmond and Mr. W. S. Bailey are to serve as associate editors, while the business interests will be in the hands of Mr. E. F. Seixas. The paper will continue as a weekly, but many improvements will be made in its form.

Current Selectors.

The controlling element in the make-up of our medical batteries seems of late to have taken the form of the graphite or carbon rheostat, through which the whole product of the cells is passed, to be reduced to what is deemed the proper current strength for the various uses to which the apparatus is put. It has been the custom to decry the use of the "selector," as being an undesirable method of using the current, the chief point of objection being liability to shock, which rendered it unfit for medical use. The point raised was not through fear of an actual break in the circuit, but because, as it was claimed, the addition of even one cell was enough to cause an injurious effect to the more delicate portion of the body. The additional argument in favor of the controller was the more even wear and tear which it allows on the cells, and the greater nicety with which the milli-ampères for measuring the current could be selected.

Were it a question of the simple selecting of milli-ampères, the point would be well taken; but recent developments in the science of electricity as applied to the human body would seem to suggest a deeper consideration than this, and from out of this fact arises another one which bids fair to restore the old style selector to its former important position. In treating disease through the medium of the current it has heretofore been thought necessary to take the voltage into consideration only in so far as having enough to overcome all resistances, great or small, was concerned. Five milli-ampères might be the quantity wanted, but the fact that 50 volts were used when 25 might have done, gave the physician no concern. It has been learned, however, that different intensities produce as many different effects, and this quite irrespective of the milli-ampèrage.

The question of resistance seems in the light of certain results to be quite laid aside, and paradoxical though it may sound it is nevertheless true. It does not seem as though the methods employed by some professed medical electricians were very scientific when they advise in their text books that a certain number of milli-ampères a re to be used

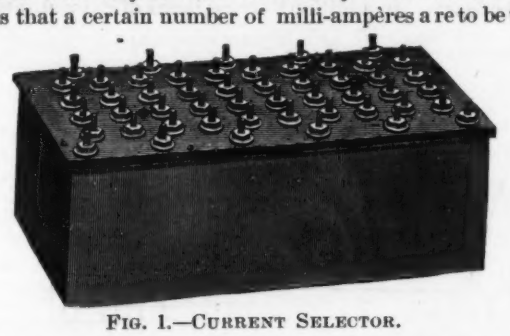


FIG. 1.—CURRENT SELECTOR.

by their brother practitioners under certain conditions, and at the same time leave out all instructions as to the number of volts. It would be better and more consistent, perhaps, to use a coulomb meter and register the amount. Such questions may seem to belong to the medical journal but they also concern the manufacturer, isasmuch as the fact that, since voltage is to play a more or less important part in the treatment of disease, the physician's outfit will have to be so constructed as to allow of its proper selection. It is here that the cell selector once more becomes an important feature of the medical apparatus. Where the whole product of the battery is used through a rheostat the voltage remains to a certain degree at least unimportant, but where it is used in connection with a cell selector an approximate estimate, accurate enough for all practical purposes, may be obtained.

The simplest form of cell selector now in use is that em-

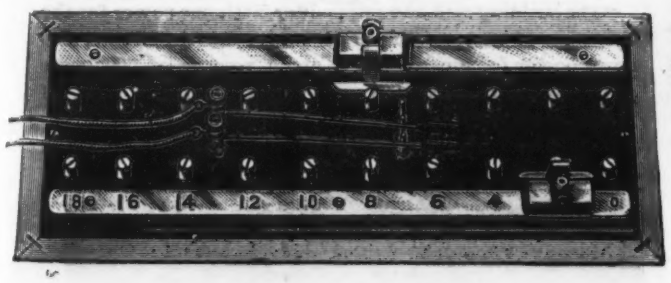


FIG. 2.—CURRENT SELECTOR.

ployed by several battery makers in their portable or hand batteries. It is simply the extension of one pole of each cell in the form of a plug or a socket whereby one or more cells may be connected with, or made part of, an external circuit. Fig. 1 conveys the best idea of the arrangement. A point aimed at in all cell selectors is being able to increase the number of cells in use without breaking the circuit. The cells in this pattern are "selected" by means of cords carrying a plug or socket, and the point is covered by having a divided cord and overlapping, thus making the increase without break.

Modifications of this form confine themselves to changes in the method of selection. The more important, so far as analytical advantage is concerned, is pictured in Fig. 2. One pole of each cell is carried above the surface of the battery top, and terminates in a broad flat plug. A strip of polished metal is fixed in line with the plugs, and forms a runner or track on which a movable gearing travels. The one end of the strip is connected to a pole, and by means of a broad spring on the running gear the cells are brought into circuit by placing the movable portion opposite the number it is desired to select. A similar arrangement on the opposite side of the battery allows of various combinations, making it possible to use the cells more uniformly. Barring the fact that it is a sliding contact, it may be said in many ways to be better than the ordinary plug and socket style, where, in a moment of forgetfulness, the operator may pull off the wrong plug and thus cause a

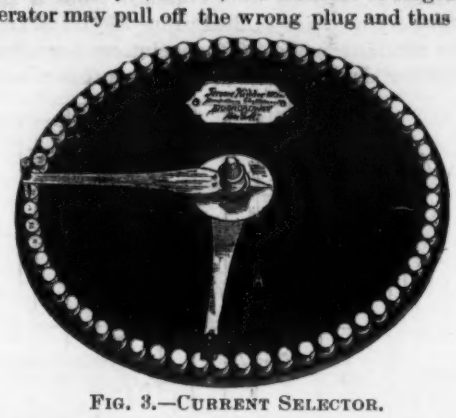


FIG. 3.—CURRENT SELECTOR.

break in the circuit which may do more or less injury to the patient who happened to be in the circuit.

The circular cell selection is by far the more preferable, both as regards convenience and practical utility, on account of its more regular action, and the fact that it does not always have to be placed in close proximity to the cells. In large stationary plants of one hundred cells or more the floor space, or closet room, is all saved by placing the batteries in the cellar beneath and leading up by wires to the selector, which will hardly occupy a space of one square foot. The moral effect, which many physicians claim forms a large element in many cases, is greatly increased, for a current obtained from an apparently hidden source is by the uninitiated more appreciated than one obtained from a source whose modus operandi is thus exposed.

The two-armed switch, Fig. 3, is the form most used.

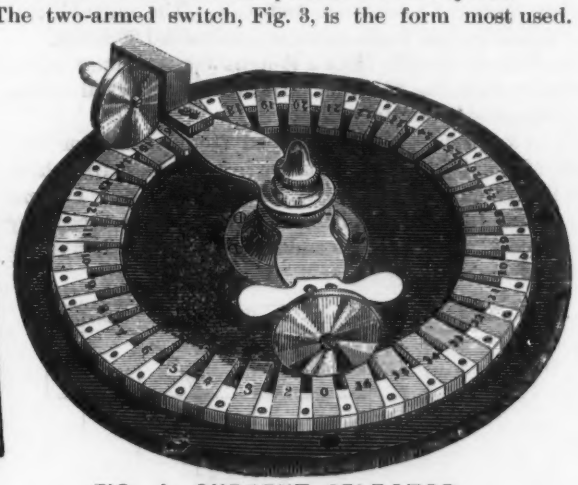


FIG. 4.—CURRENT SELECTOR.

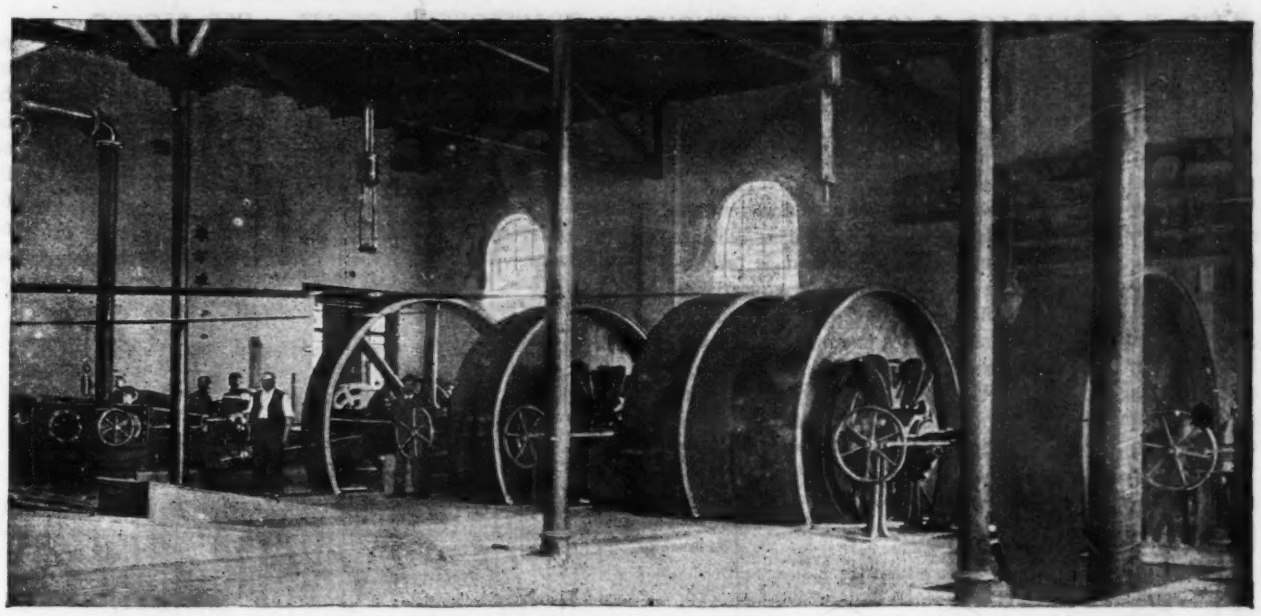
The additional arm allows of one or more calls being selected in any portion of the circle. In the circular arrangement pictured above, there has been one danger of break in the current by the liability of the operator to lift the sliding arm off the plugs or buttons. This has been overcome by having a spring extend down and over the outside of the buttons, which makes it impossible to cause a break. In another style the arm rests on very flat buttons, and the contact is always rendered secure by the arm itself being part of a spring which it is impossible to lift away from contact. Fig. 4 represents an instrument which has been much used. The sliding contact is replaced by a wheel which travels over the surface of blocks of metal separated by insulating partitions of ivory. As a mechanical instrument it is very good, but electrically it is not equal to any of the above. The point of contact is so minute that very little dirt or foreign matter is required to break contact.

The one-armed style of switches do not admit of much variety. One of the best of these is one in which a socket is made to take the place of a second arm. There is a danger in this variety, however, of an accidental reversion of the polarity of the battery, as, should the socket happen to be placed on the wrong side of the arm the current would be turned in the opposite direction.

The chief point of objection to cell selectors is, as has been stated, a supposed danger to shock from the adding of cells. In many cases the addition of a cell means but a very slight increase in the strength of the current. The remedy, however, has been to use all the cells through a controller. Then the objection is raised that the voltage is not under control. The proper solution is to have a battery that has both current controller and cell selector.

Some Large Friction Clutches.

The Falls Rivet and Machine Company, of Cuyahoga Falls, O., has recently put in some clutches at the power station of the Consolidated road at Columbus, O., which are said to be the largest yet made of that type. Four friction clutch pulleys, shown in the figure, each 12 ft. in diameter with a 38-inch face, are carried on a single steel shaft 36 feet 6 inches long and 9½ inches diameter. The clutches were built for 500 h. p., but tests have shown they transmitted over 700 h. p. each, to a single pulley at 120 revolutions. The pulleys are of wood with a steel rim on the outside, which makes them very desirable for large pulleys, being so much lighter than iron ones. This line of shafting is driven by two Buckeye engines of 1,000 h. p. each, connected together by clutches at each end of the line shaft. This arrangement of one engine at each end of the shaft with a clutch from each engine, permits of either engine



SOME LARGE FRICTION CLUTCHES.

driving any generator, or when necessity requires, the second engine can be connected to service without reducing the speed of the working engine in order to do so. The completion of the building before this contract was placed prevented the addition of a friction cut-off coupling in the centre of the shaft, so that half of the plant, including the shafting and two pulleys as well as one engine, could stand idle if desired.

The "Pollock" Tramway System.

To the Editors of the Electrical World:

In the last number of your valuable paper you publish a letter from a gentleman from Frankfort-on-Main, which has reference to my article on underground systems for electric street railways (THE ELECTRICAL WORLD, March 19). I would not have thought worth while answering this letter if the gentleman in question had not come forth with his pretensions in such an objectionable way as he does, and if he did not claim the arrangement of the sectional rails with boxes, worked by magnets on the car, as his own. In your editorial note you mention that the description and illustration have nothing to do with the system of the gentleman from Frankfort-on-Main, and as to his second claim that he was the first to propose the sectional rails worked by magnets on the car, I would say that, as far as I am aware, Professors Ayrton and Perry proposed this arrangement as early as 1883, if I remember it correctly.

Yours truly, F. BOLLING.

Business Prospects of the Westinghouse Company.

The Boston *News Bureau* is responsible for the statement that the Westinghouse Electric Company is at present employing at its factory 1,200 hands, 500 of whom are on the night force, and if the factory at New York is included the total number of employés reaches 1,800. About 60 motors per week are turned out, and it is expected that this number will soon reach 100. The aggregate capacity of the weekly output of generators is 1,000 h. p., and this will soon be doubled. The number of incandescent lamps manufactured daily is about 1,000. In an interview Mr. Westinghouse, after some quotations from the annual report, which was published in THE ELECTRICAL WORLD of May 28, 1892, said that the company was doing a snug cash business and had all the money it needed. The large experimental force has been greatly reduced. He thought the company would show a gross business of $6,000,000 the present fiscal year.

Magnetization Curves of Iron Under Alternating Currents.

BY J. E. MOORE AND E. M. TINGLEY.

Recent discussions concerning the losses in iron subjected to the magnetizing effect of alternating currents has led the writers to this investigation. Several practical methods of experimenting presented themselves, but the one finally decided upon was that based upon the one proposed by Dr. Duncan in THE ELECTRICAL WORLD of Nov. 14, 1891.

This method has been described by its inventor, so that a description is unnecessary here. It consists essentially in passing the alternating current to be measured through the stationary coil of an electro-dynamometer and in passing a direct current through the movable coil at a definite point in each recurring cycle. The deflection is proportional to the product of the strengths of the two currents during the short time in which the direct current is flowing. Since the instantaneous current is constant in value, the reading of the dynamometer will give the intensity of the alternating current at the point at which the instantaneous current flows. The value of the alternating current can thus be obtained at any number of points. Values so found and plotted as ordinates with the corresponding abscissæ will give a curve showing the current strength at any instant. By using a large inductionless resistance in circuit with a second dynamometer, the E. M. F. may be obtained in the same way. By substituting known continuous currents and electromotive forces, the instruments may be calibrated.

The instantaneous values of current and E. M. F. thus determined are plotted in their proper phase and magnitude. From the E. M. F. curve the change of induction may be determined. If N is the number of lines of force included by the circuit, and e the E. M. F., then $e\,\delta t = \delta N$, or a curve with ordinates calculated from integrating the E. M. F. curve, between the proper limits, will show the induction.

In a transformer with a load on the secondary, the magnetizing force at any instant will be the algebraic sum of the primary and secondary ampère turns. The corresponding values of the magnetizing force and the induction plotted on rectangular co-ordinates will give the magnetization curve. The area of this curve will be proportiona to the energy lost in one cycle.

This method has been applied to commercial transformers and to small rings of transformer plates. The arrangement for testing transformers is given in Fig. 1.

The alternating currents were obtained from a small eight pole Slattery machine in the Purdue Electrical Laboratory. The machine made 2,070 revolutions per minute. The commutator device shown in Fig. 2 consists of a hard wood disc 5½ inches in diameter, with four brass contact pieces ⅛ inch wide on the periphery. The movable brush is carried on an arm moving over a graduated semi-circle. One-tenth of an ampère, as shown by a tangent galvanometer, was used in the direct current circuit. The current dynamometers were of the Siemens pattern and of the ordinary size. The voltmeter was a unifilar dynamometer read by means of a telescope and scale. The movable coil was 15 millimetres in diameter and contained 80 turns.

Fig. 3 gives results from a 40-light Westinghouse transformer working on 28 lights. The actual observed values are connected by straight lines.

Fig. 4 and 5 give results obtained from an anchor ring made of 24 plates of transformer iron ½ millimetres thick and 11 centimetres in diameter. The magnetizing current was taken from a 50-light transformer. The secondary contained 27 turns with an additional induction less resistance of 900 ohms.

By this method of using small rings fewer instruments are necessary, and the results are more accurate and may be expressed in C. G. S. units.

In the above curves the effects of Foucault currents have been neglected, as the same thickness of iron is generally used in transformers.

It is proposed to apply this plan of working to the magnetometer method, as it has already given some promising results.

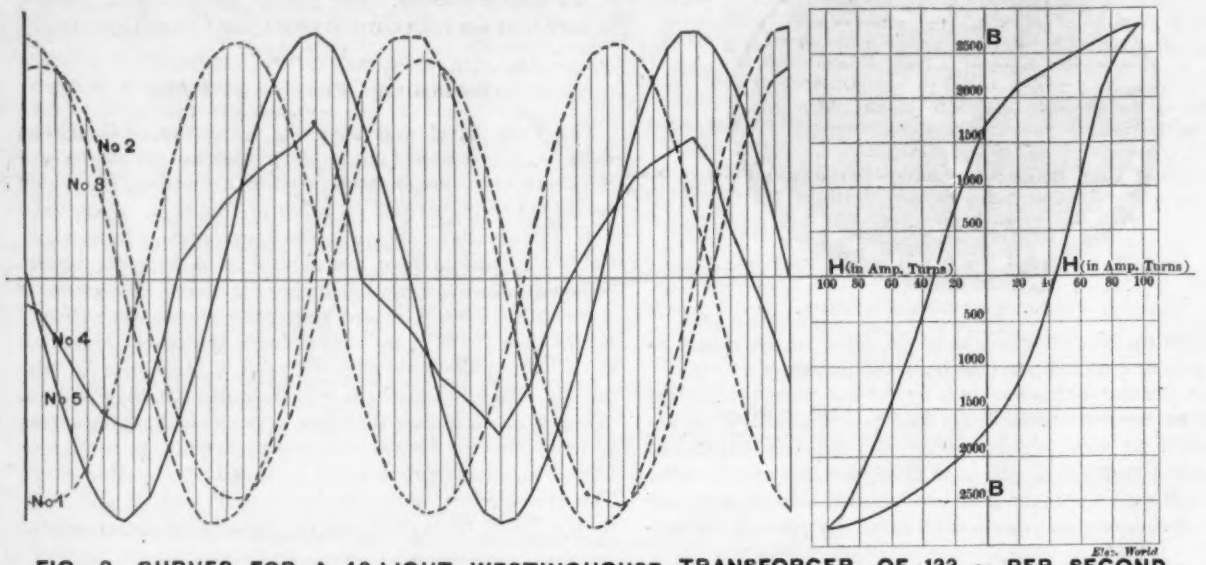


FIG. 3.—CURVES FOR A 40-LIGHT WESTINGHOUSE TRANSFORCER, OF 133 ~ PER SECOND.
No. 1.—Primary ampère turns. No. 2.—Secondary amèpre turns. No. 3.—Secondary E. M. F. No. 4.—Resultant ampère turns. No. 5.—Induction (B).

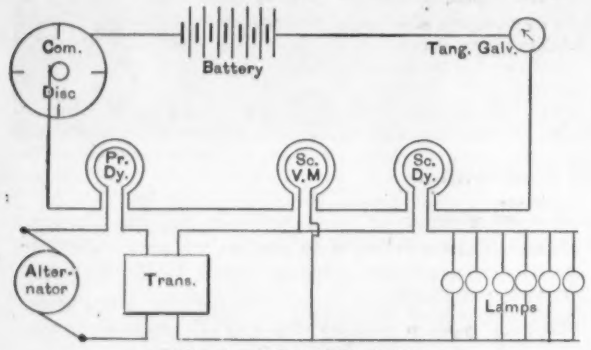


FIG. 1.—CONNECTIONS.

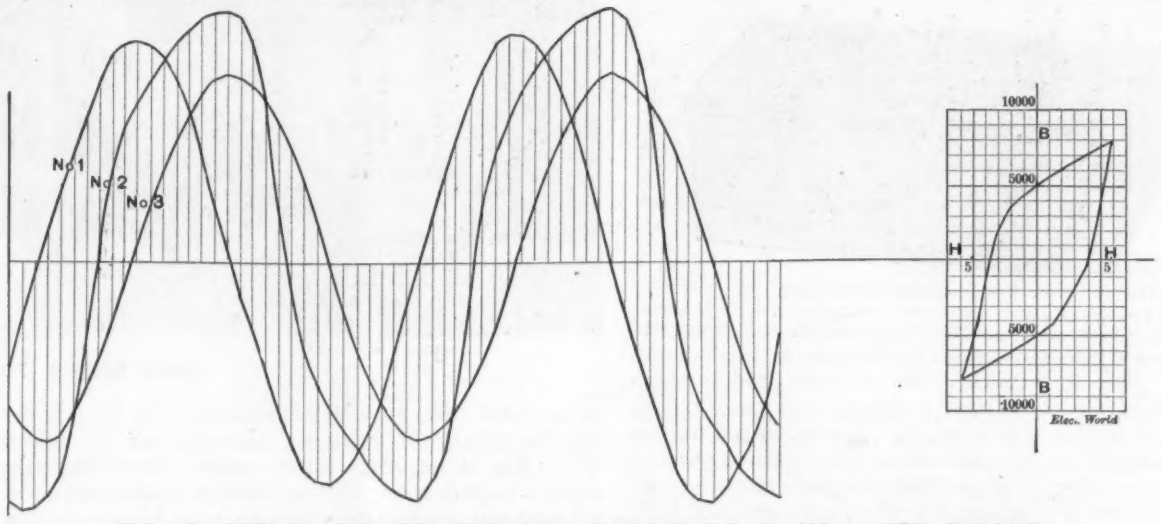


FIG. 4. CURVES FOR TRANSFORMER SAMPLE NO. 3. 138 ~ PER SECOND.
No. 1.—E. M. F. No. 2.—Current. No. 3.—Induction (B).

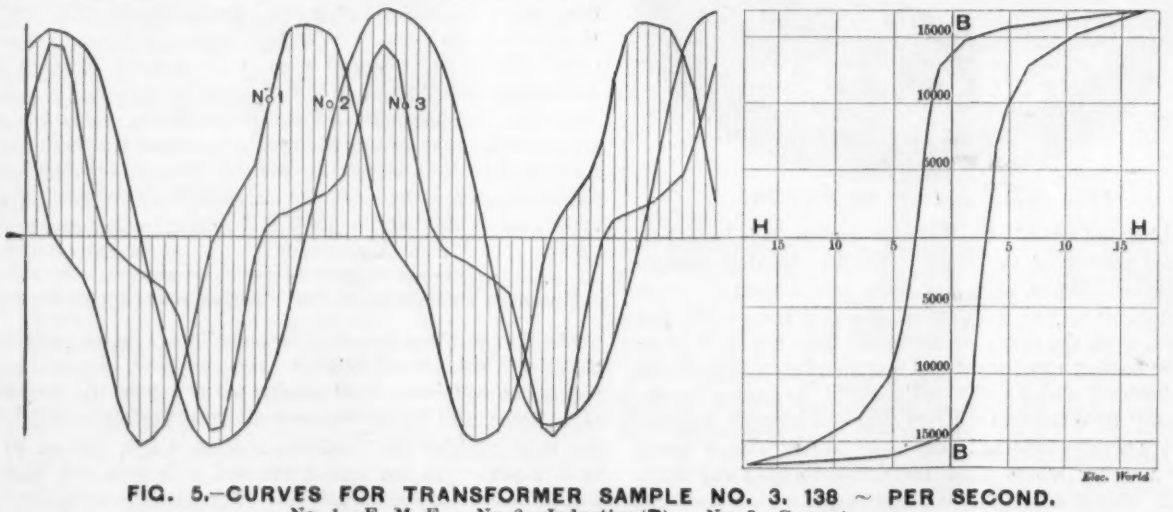


FIG. 5.—CURVES FOR TRANSFORMER SAMPLE NO. 3. 138 ~ PER SECOND.
No. 1.—E. M. F. No. 2.—Induction (B). No. 3.—Current.

Information for World's Fair Exhibitors.

In order that exhibitors should have a clear understanding as to the conditions under which exhibits are to be made, as well as to give the World's Fair officials a more exact idea of the extent and nature of the exhibits, Prof. J. P. Barrett, chief of the electrical department, has issued the following letter, which is self-explanatory:

"It is the purpose of the exposition management to allow exhibitors to completely equip the Electrical Building for lighting and power. With a view to determine just what may be done in this direction, the department of electricity chooses to place its plans before those who are interested in its success, and advise with them with a view to giving them an opportunity to participate in this equipment.

"Under the rules of the exposition it will be necessary to plant all operating machinery in what is to be known as the general power plant (marked *A* in the accompanying map.) All generators will be established at that point immediately adjacent to steam power of competent capacity. Between this power plant and the Electrical Building, there is a subway six feet deep and six feet wide for the accommodation of conductors. Fire proof vaults will be built at the point of entrance into the Electrical Building in which to install transformers, to comply with the National Underwriters' requirements. Headway averaging seven feet under the flooring and foundation posts at intervals of 12 feet will give ample wiring facilities.

"It is the purpose to divide the building into equitable sections and to assign these sections to the various exhibiting interests. Those to whom assignments are made will be expected to install their own generators, furnish cables between the plant and the building, and do all wiring, including the furnishing of wire. Those who are given arc lighting to do will be expected to furnish carbons and attend to renewing same. Those undertaking to operate incandescent lamps will be expected to furnish all renewals and attendance. In addition to these items of expenditure, all exhibitors whose generators are operated from steam in the power station will be asked to pay pro rata the costs incident to the erection of the machinery. Belting from shafting to generators must also be furnished by exhibitors, and exhibitors of alternating systems will be asked to contribute to the expense of constructing the transformer vault.

"The building will be equipped for 500 horse power for the operation of motors, 500 horse power for arc lights, 500 horse power for incandescents and a reserve of 500 horse power for extra incandescents, applications for most of which are already in.

"In order that the plant for this building may not be a source of expense to the exposition management, a charge will be made for any special arc lighting desired by exhibitors who do not participate in the equipment and electrical supply of the building, also against the same class of exhibitors who desire power for motors or who require incandescent lamps. The charges do not concern any who contribute to the expenses cited above.

"In order that the above proposed system may be reduced to a definable quantity I beg leave to submit the inclosed

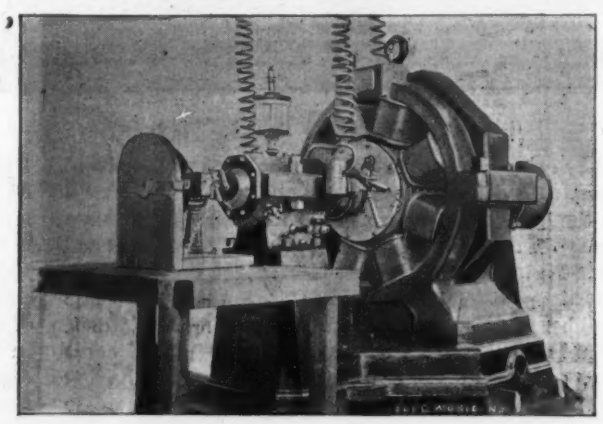


FIG. 2.—SHOWING COMMUTATOR DEVICE.

blank, which please fill out completely and return to me at once."

TO EXHIBITORS IN THE ELECTRICAL DEPARTMENT OF THE WORLD'S COLUMBIAN EXPOSITION.

Do you desire to participate in the electrical equipment of the Electrical Building on terms in accord with the accompanying circular?

Is your exhibit designed to include generators operated under load?

If so, how many, what capacity, what minimum steam power required, nature of current and character of work intended to be done (motor, incandescent or arc lighting)?

What floor space will generators and adjuncts occupy (send scale drawing and confine as much as possible)?

How many arc lamps will you exhibit?

How many incandescent lamps will you exhibit?

How many motors will you operate, of what sizes, and how much *power* for motors?

Do you desire to equip your own space for arc lighting?

For incandescent lighting?

For motor power?

Do you desire to equip additional space in the general scheme and if so how much, and for what purposes?

Financial Intelligence.

THE ELECTRICAL STOCK MARKET.

NEW YORK, May 27, 1892.

Review of the Market.—The changing conditions of the market this week have clearly shown that it is a weather market. The reports from the West have fluctuated between clear and stormy weather, telling first of rising and then falling water in the flooded regions, and as these reports have varied in their character so have the stocks fluctuated according to the outlook that present conditions seemed to foreshadow. These weather reports primarily affect the railroad stocks, and as leaders in the market their course is a criterion for the general conditions of strength and weakness that characterize the rest of the list. So long as the larger part of the trading originates on the floor of the Exchanges there is slight probability of any material change of a permanent character until the disturbing elements are removed sufficiently and permanently to allow the public to take hold once more on their own account. We note, however, a slight impetus in favor of steadier and better conditions, and if daily indications bring permanent results we will soon have a better market. Call loans have been made at 1½ per cent.; and prime commercial paper loans at 3 to 5 per cent.

The electric stocks have maintained their usual strength, and have been firm in prices, with only slight fluctuation. Absence of any new plans of the companies has caused interest in these stocks on the street to be rather light, and they are simply waiting for something to turn up to start a good activity at higher figures. Thomson-Houston has regained its dividend and sells again at 67. Edison closed very near the maximum price and is also strong. Rights on General Electric Company's stock have sold at 65 cents to 85 cents. This at once puts a premium on the subscription price of the new bonds and brings them to nearly or over par, according to the price of the rights, figuring on 85 shares per bond. A holder of Thomson-Houston preferred stock must own 340 shares, and of common stock 141⅔ shares, to be entitled to a subscription to one bond of the General Company. This is on the basis of 85 shares of General stock per bond. The aggregate results of the auction sales of the West End Railway Company stock have proved most favorable to the company. Considering that the stock was all underwritten any way, it is not surprising that it had sufficient backing to advance the prices on such large sales. This may be considered a good test of the plan of putting out new stock by the auction process, but there are still two sides to the question of its advisability and entire fairness to old holders. As the new stock carries the July dividend, it places stock only two months old on the same basis with original stock which has been held for a year or more. Western Union has been very strong, and closes at the end of the week at highest figures yet recorded. The sales have been larger than usual. The character of the buying promises still higher figures. Bell Telephone has sold very little, and remains strong and steady. Westinghouse has been weak and very quiet; a little manipulation served to put it off a point or two, and it failed to rally.

United Electric Securities Company.—The United Electric Securities Company invites proposals for sale to the company of $15,000, $30,000 and $35,000 of its collateral trust sinking fund 5 per cent. bonds, second, third and fourth series respectively. Proposals will be received until 12 o'clock, May 31, 1892.

The General Electric Company.—Owing to some inequalities in the application of the subscription privilege as outlined in the circular of the General Electric Company, offering $4,000,000 bonds, the circular will be withdrawn, it is stated, and another substituted, which will make provision for the transfer of rights.

Westinghouse Electric.—Answering an inquiry recently in regard to the Westinghouse Electric, "Rialto" in the Boston *Advertiser* stated the following: "The Westinghouse stock certainly looks cheap around present prices, and in the event of another upward movement in the local market will undoubtedly be taken in hand and put up to much higher figures. The preferred stock is earning and paying full dividends, and before another year the common will be on the dividend list and take rank as a solid investment stock. At present I should say it was a remarkably good speculation."

Annual Financial Statements.—That of the Rocky Mountain Bell Telephone Company, recently filed, states that the paid up capital stock amounts to $305,000 and places the value of its franchise at $195,000. The company's surplus is $64,904.38 and its reserve fund $36,992.95. The treasurer's report at the recent annual meeting of the Providence, R. I., Telephone Company shows the gross earnings of that company to have been $230,911.71; expenses, $136,911.71; dividend paid, $54,000; amount carried to surplus, $20,000; total surplus, $54,628.60.

Street Railway Bond Offerings.—Gay & Stanwood of Boston have purchased and are offering $500,000 of six per cent. first mortgage gold bonds of the Trenton Passenger Railway Company, consolidated, of Trenton, N. J. The company combines the interests of the Trenton Horse Railroad Company, the City Railway Company, the Hamilton Township Street Railway Company, and the South Clinton Avenue and Broad Street Railway Company. The bonds are of $1,000 each, due 1,931, interest payable April 1 and October 1. The following shows the operations of the company by horse power for 1891.

Gross receipts from all sources	$131,969.51
Operating expenses	86,464.82
Net earnings	$45,504.69
Interest on all outstanding bonds ($190,000) at six per cent.	11,400.00
Net surplus for the year 1891	$34,104.69

A careful and conservative estimate of the operations of the company for the year 1892, with a part of the road equipped with electricity, shows an estimated surplus for the year of $50,000. This estimate makes no account of the increased receipts and decreased operating expenses which will inevitably follow the introduction of electric traction. It is expected that the conversion of the whole system from horse power to electric power will be accomplished by June 1, 1892. The company owns and operates 28½ miles of track, real estate valued at $144,000, 64 cars, 17 electric vestibuled cars, 10 electric open cars, 355 horses, etc. The sinking fund is amply provided for and has $10,000 bonds coming due and payable in 1906, and $10,000 annually thereafter up to and including 1915. In 1916 $15,000 will be retired and the same amount annually thereafter up to and including 1925. $20,000 become payable in 1926 and the same amount for the five succeeding years, by which plan over one-third of the total mortgage is retired prior to 1931, when the remaining $650,000 bonds mature.

Municipal Bonds for Sale.—The town of Peabody, Mass., through its treasurer, offers for sale 40 electric light bonds, $1,000 each, dated June 1, 1892, running 30 years and paying 4 per cent. interest. This constitutes the electric light loan of the town.

West End Railway Sale of Stock.—The last lot of the West End Company's common stock was sold at auction Tuesday. It was a block of 700 shares, and makes an aggregate of 38,700 shares sold altogether. The total amount realized, not including the commission, is $2,855,756.25, or $5,756.25 more than was announced in the circular as desired. The highest price secured was 76⅝ May 24, and the lowest was 72½ on May 4, 5 and 6. President Whitney states that the amount realized from the sale is sufficient to liquidate all the floating debt of the company. He also says that the commission amounts to a comparatively small sum. No more stock will be put out for some time.

Dividends.—The West End Street Railway Company, of Boston, has declared a semi-annual dividend of 5 per cent. on the common stock, payable July 1. The new stock recently sold by auction shares in this dividend.

Increase in Capital Stock.—The Bement Electric Light and Power Company, of Bement, Ill., has certified to an increase in capital stock from $2,000 to $5,000. The Springfield Electric Light Company, of Eugene, Ore., has increased its capital stock from $10,000 to $50,000. The Electric Light, Heat and Power Company, of Media, Pa., has increased its capital stock from $40,000 to $100,000.

The Detroit Electrical Works has reduced its capital stock from $1,000,000 to $750,000, all of the latter being paid in.

Closing Quotations.—The following were the closing quotations of electric stocks on Friday, May 27, 1892, in New York and Boston:

NEW YORK QUOTATIONS.

Name of Stock.	Par.	Capitalization.	Bid.	Ask'd.
American Cable	...	.....	85½	88
American Telegraph Co.	100	14,000,000	60	63
Western Union Telegraph Co.	100	86,200,000	94½	94⅝
Commercial Cable Co	100	7,716,000	155	160
Edison General Electric	100	15,000,000	110⅝	111¼
Edison Illuminating Co., of New York	100	4,500,000	79½	80
" " " Brooklyn	100	750,000	76	80
" " " Chicago	100	750,000	138	142
U. S. Illuminating Co.	100	1,250,000	30	35
Edison Elec. Light Co. (of Europe) stock	100	2,000,000	2½	5
Edison Elec. Light Co. (of Europe) bonds	sh	30,000	65	75½
" Ore Milling Co	100	2,000,000	15	20
" Toy Phonograph Mfg. Co	10	1,000,000	....	½
Brush Illuminating Co., of New York	50	1,000,000	40	50
Mt. Morris Electric Light Co.	..	500,000	20	40
East River Electric Light Co.	100	1,000,000	....	60
North American Phonograph Co.	...	6,600,000	5	8
New York Phonograph Co.	...	2,000,000	3	4
Automatic Exhibition Co.	...	2,000,000	3	6
New England Phonograph Co.	...	2,000,000	1¾	2¾

BOSTON QUOTATIONS.

	Par.	Capitalization.	Highest.	Lowest.	Bid.	Ask'd.
Thomson-Houston Elec.	25	6,000,000	67	65⅝	66½	66¾
Thomson Houston Elec. preferred	25	4,000,000	30⅛	29⅞	29¾	30
Thomson-Houston Elec.—Series C	sh	40,000	....	....	8½	9
Thomson-Houston Elec.—Series D	sh	120,000	7¼	..	7¼	7⅜
Thomson-Houston Int'n'al Elec.	100	600,000	....	....	....	240
Thomson-Houston Int'n'al Elec—Pfd	100	400,000	....	....	103	105
Thomson Elec. Weld.	100	1,000,000	....	....	...	55
Thomson European Elec. Weld	100	1,500,000	10	....	10	12
Westinghouse Elec.—New Com.	..	6,000,000	28¼	27½	27¾	28¼
Westinghouse Elec.—Pfd.	..	4,000,000	15½	45	45½	46
" "						
Fort Wayne Elec.	25	4,000,000	12¾	12⅜	12½	12¾
Fort Wayne Elec.—Ser. A.	sh	80,000	7½	....	7⅞	7½
Detroit Elec.	10	1,000,000	8	7¾	....	8½
West End St. Ry. Co.—Com	50	7,150,000	77	74¼	75¾	76
West End St. Ry. Co.—Pfd	50	6,400,000	89¾	88¼	89½	89¾
American Bell Tel	100	15,000,000	208	207½	208½	209
Erie Tel. & Tel. Co.	..	4,800,000	45½	45	45	.....
Mexican Tel. Co.	10	1,280,000	1.10	....	1.05	1.10
New Eng. Tel. & Tel. Co.	..	10,304,600	53	52½	53	.....
Tropical Tel. Co.	10	400,000	25	....	25	35

NEW INCORPORATIONS.

The Elk Ridge Coal and Coke Company, of Elkhorn, W. Va., capital stock $50,000, has been formed to generate electricity, etc. J. H. Bramwell, C. W. Seaman and I. P. Mann, all of Elkhorn, are the organizers.

The Brownsville Electric Light Company, of Brownsville, Pa., capital stock $7,000, has been formed to generate and supply light, heat and power by electricity. Frank P. Kifer, Jos. S. Eliot and Wm. E. Ledger are the incorporators.

The Union Electric Company, of Louisville, Ky., capital stock $50,000, has been started to manufacture and deal in electrical instruments and supplies. The incorporators are Jas. Marret, J. M. Biggs, John Welch and J. M. Williams, of Louisville.

Home Electric Light and Power Company, of Muscatine, Ia., capital stock $150,000, has been formed to furnish electric light and power at Muscatine, also power for a street railway. The promoters are S. G. Stein and F. P. Sawyer, of Muscatine.

The Glendale Electrical Company, of Glendale, W. Va., capital stock $50,000, has been formed to furnish light, heat and power by means of electricity. William Erskine, D. L. Hukill, Wheeling, W. Va., and J. M. Booth, of Moundsville, W. Va., are the incorporators.

The Falls City Electric Company, of Louisville, Ky., capital stock $10,000, has been formed to manufacture, etc., Hanson primary batteries, etc. Nicholas Finger, Geo. A. Foree, E. D. Foree, J. B. Quinn, W. J. Wilson, H. F. Smithers, all of Louisville, are the promoters.

The Harrisburg and Mechanicsburg Electric Railway Company, of Harrisburg, Pa., capital stock $75,000, has been incorporated to construct and operate an electric railway between the two towns. E. Z. Wallower, Frank R. Leib and S. W. Fleming are the promoters.

The Western Temperature Regulation Company, of Chicago, Ill., capital stock $60,000, has been formed to operate the Johnson Electric Service Company patents for temperature regulation. Chas. A. Barker, Polhemus S. Hudson and Arthur A. Simmons are the promoters.

Standard American Electrical Company (incorporated in West Virginia), New York, capital stock $3,000,000, has been formed to manufacture and deal in electrical machinery of every description, etc. J. H. Storm, W. H. Weed and Chas. N. Codding, of New York, are the incorporators.

The General Fixture Company, of New York City, capital stock $600,000, has been formed to manufacture, buy, sell and use all kinds of electric fixtures, etc. Samuel Insull, 44 Broad street; Joseph Hutchinson, 292 Avenue B. and Edward A. Stevenson, 292 Avenue B. New York City, are the promoters.

The Walden Electric Light and Power Company, of Montgomery, N. Y., capital stock $10,000, has been formed to manufacture and use electricity for light, heat, power, etc. Joseph Broadhead, West Cornwall, N. Y.; Nich. J. Fowler, Irving, and H. Loughran, of Walden, N. Y., are the promoters.

The Ukiah Electric Company, of San Francisco, Cal., capital stock $30,000, has been formed to generate and deal in electric lights, and to operate telephone and telegraph lines. George Johnson, C. B. Johnson, John Cosgrove, John Smith and Frank Boyd, all of San Francisco, Cal., are the incorporators.

The National Automatic Fire Alarm Company, of Chicago, capital stock $300,000, has been started to construct and operate electric fire alarms, telegraphs with annunciators, thermostats, electric valves, etc., etc. Frank C. Elliott, Horace C. Alexander and Fremont Hill are the incorporators.

The South Side Railway Company, of Denver, Colo., capital stock $150,000, has been formed to build and operate a system of electric railway lines in the county of Arapahoe. The incorporators are John C. Montgomery, James Leonard, Stanbery Sherwood, Frank B. Gibson and Calvin P. Butler, all of Denver.

The Newtown Electric Light and Power Company, Newark, N. J., capital stock $150,000, has been formed to construct and operate works to supply electricity for light and power. J. N. Seeley, Brooklyn, N. Y.; C. O. Baker, Jr., Newark, N. J., and C. F. Porter, New York City, are the promoters.

The Aluminium Insulated Wire Company, of New York City, capital stock $2,000, has been formed to manufacture and sell insulated cables and wire and electrical machinery, instruments and supplies. Wm. J. Mollan, 1,804 Park avenue; Chas. C. Buddington, 221 East 126th street and Thos. T. Goodenough, 333 East 125th street, all of New York City, are the parties interested.

AFFAIRS OF THE COMPANIES.

The Gany Magneto-Electric Company will hold its annual meeting at No. 1 Exchange place, Jersey City, N. J., on Tuesday June 7, for the election of officers, etc.

The Worcester & Millbury Electric Railway Company, of Worcester, Mass., at a recent meeting of its stockholders elected A. Winslow president and T. T. Robinson clerk.

The Detroit Electrical Works expects to double its capacity within thirty days by the addition of new machinery. It has closed a contract for the equipment of the principal avenue in Detroit, for which it will receive $100,000.

The Santa Cruz Electric Light and Power Company, of Santa Cruz, Cal., at its recent annual meeting elected the following officers and directors: Dr. H. H. Clark, president; A. P. Swanton, vice-president; F. W. Swanton, secretary and manager. Directors: J. F. Appleby, C. E. Lilly, Dr. H. H. Clark, A. P. Swanton, F. W. Swanton.

The Citizens' Street Railway Company, of Indianapolis, Ind., at its recent annual meeting elected the following board of directors and officers: Board of Directors—Samuel W. Allerton, L. L. Coburn, William B. Walker, E. M. Fowler and E. K. Butler. President, John P. Frenzel; Vice-President, Samuel W. Allerton; Secretary and Treasurer, A. A. Anderson.

The Atlanta Consolidated Street Railway Company, of Atlanta, Ga., held an adjourned meeting of its stockholders on May 23. The following directors and officers were elected: Directors, Oliver Ames, Eugene Griffin, J. F. A. Clark, Alfred A. Glasier, G. W. Mansfield and Winthrop Coffin, of Boston; John H. Watson, of New York; Frederick Ayer, of Lowell; Joel Hurt, H. E. W. Palmer, A. E. Thornton, Robert J. Lowry and W. H. Patterson, of Atlanta, Ga. President, Joel Hurt; vice-president, Eugene Griffin; secretary and treasurer, Alfred A. Glasier; assistant secretary and assistant treasurer, H. I. Bettis; 17,989 out of 20,000 shares were voted at the meeting.

Special Correspondence.

NEW YORK NOTES.

OFFICE OF THE ELECTRICAL WORLD,
167-176 TIMES BUILDING, NEW YORK, May 28, 1892.

The Electric Club gave a very enjoyable musical entertainment to its members and friends on last Friday evening at the club house, 17 East 22d, street. The financial condition of the club is very encouraging now and a very successful year is looked forward to.

A New Time Ball.—There has been no time ball on the Western Union Building since the fire on July 19, 1890, but a new one is expected to be ready in a few days. An iron structure is being erected on the southwest corner of the building and the top of the pole will be 100 feet from the roof or 300 feet from the street. The ball will be three feet and a half in diameter and visible from the harbor. It will be controlled by the clock at the Government Observatory at Washington.

The Board of Managers of the New York Electric Club, at their monthly meeting, held at the club house, 17 East Twenty-second street, Thursday, May 19, 1892, elected the following members: Active—Mortimer M. Hayden, John F. Zebley, E. C. Brown. Associate—Geo. Urban, Jr.; D. T. Everts, S. L. Phillips, C. I. Hills, J. A. Seymour, A. J. Belden, Chas. J. Mayer, J. Calisch, R. J. Getz, C. H. McIntire, G. F. Wheeler, F. P. Little, John E. McIntosh, Howard H. Crowell, E. T. Pardee, Samuel G. Booker, Chas. R. Lloyd, C. S. Knight, D. F. Urquhart.

From St. Louis to Chicago by Electric Express.—The Electric Club has issued an announcement to the effect that arrangements have been made for a lecture on this subject by Dr. Wellington Adams, of St. Louis. The date announced is Thursday evening, June 2, at 8 o'clock, and the lecture will deal with the engineering and commercial features of this projected high speed electric road. Lantern slides will be shown illustrating the details of construction and it is expected that this will be one of the most interesting lectures that the club has been able to secure.

Brooklyn's Subway Commissioners.—Mayor Boody has appointed two members of the new Electric Subway Commission

under the law enacted at the last session of the New York Legislature. The commissioners appointed are Prof. George W. Plympton and Frederick R. Lee. Professor Plympton was a member of the old Subway Commission, and has charge of the Scientific Department of the Polytechnic Institute. Mr. Lee is a lawyer and has been prominent in local politics. The new commissioners will hold office until Nov. 1, 1896, and have salaries of $3,000 a year each, which are to be paid in monthly installments, as well as necessary incidental expenses, by the different electrical companies whose wires are put under ground. At the expiration of the terms for which they are appointed their duties shall devolve on the Mayor and City Works Commissioner. L. H. H.

NEW ENGLAND NOTES.

Branch Office of The Electrical World,
Room 28, Hathaway Building, 620 Atlantic Ave.,
Boston, Mass., May 26, 1892.

L. S. Starrett, Athol, Mass., manufacturer of fine tools for electrical work, has just issued a handsome catalogue.

The Shawmut Fuse Wire Company, through its general manager, Mr. Robb, report business in its line as very satisfactory, particularly in the sale of fuse wire.

The Robinson Motor and Battery Company, Hancock Building, reports already an active demand for its fan motors, and looks for a large business in its line this summer. The company also manufactures other specialties.

The Germania Electric Company has moved its offices to No. 620 Atlantic avenue, Boston, Rooms 46 and 47. Dr. F. A.C. Perrine formerly of the John A. Roebling Sons' Company has become the treasurer of the Germanic Company.

The Silver Lake Company, Boston, is making a specialty of braided cord for use in covering field magnets, trolley cord, arc lamp cord, besides cord manufactured especially to suit the severe usage consequent in the street railroad service.

The Bunker Hill line to the Albany and Old Colony depots is now operated by electricity. After turning into Beach street, on southbound trips, this line will be run via Beach, Lincoln and Kneeland streets to Federal street, passing the depots and returning same route.

The B. F. Sturtevant Company, Boston, is now introducing a combination motor and blowers; also a combination motor and forge. This is, in consequence of electricity, superceding steam in many manufacturing establishments and the demand for these goods has called for this new departure.

The American Twist Drill Company, Laconia, N. H., is receiving very flattering accounts of the performance of its clutches from such concerns as the Amory Manufacturing Company, Manchester, N. H.; the Amoskeag Manufacturing Company, Manchester, N. H., and the Stark Mills, Manchester, N. H., also from the Thomson Electric Welding Company, Lynn. Mass.

Weymouth & Hingham Street Railway.—A meeting of prominent business men at Masonic Hall has been held to boom the building of the proposed Weymouth & Hingham Street Railway. The following were appointed to investigate the cost of construction: Messrs. Dizer, Clapp and Richards. Major Hart was delegated to petition the selectmen for a relocation of tracks.

The Selectmen of Brookline gave a hearing to the petitioners for the extension of the Beacon street boulevard so as to provide a belt line of electric cars from the Tremont House, Boston. About two hundred and fifty citizens and taxpayers were present. A. D. Chandler appeared on behalf of the petitioners and urged the granting of the petition as the solution of the transit problem. The entire cost would be only $250,000. The hearing was adjourned to the evening of May 27.

The New England Electric Club has secured spacious apartments at 14 Bosworth Place, Boston, Mass., comprising 11 rooms. The officers of the club are as follows; C. S. Knowles, president of the Knowles Rubber Company, president; E. A. Peckord, vice-president, Lynn; M. Hayes, Night City Editor Boston *Globe*, secretary; A. O. Smith, of the Eastern Electrical Supply Company, treasurer. It is proposed during the winter months to add a course of lectures and debates.

Electric Cars Over the Harvard Bridge.—More than two weeks ago the Cambridge Board of Aldermen passed an order giving the West E. company permission to place the trolley system on the bridge, on condition that six cars per hour be run to and from Harvard square and Tremont House. Vice-President Cummings, of the West End company, appeared before the board and objected to the condition. He was successful in having the order changed, the road agreeing to put into service as many cars as may be necessary. Another clause was introduced into the order, however, binding the West End to adopt at any time any other system of electric motive power that the board may suggest, or take up its tracks.

A Telephone Cable.—The tugs "Emily" and "Atlas" with the assistance of the wrecking lighter "Aid," on the stern of which was a large coil of wire, has succeeded in laying a telephone cable for the New England Telephone Company across the stream from the East Boston side of the South Ferry to the city proper. The cable, which is laid at the bottom of the stream, directly underneath the route of the ferryboats, is connected on the city side with wires running to the edge of the water on Eastern avenue, and with those in East Boston at the end of Lewis street. It was put across the stream at this point, to avoid the possibility of any accident by being dragged up by the anchors of vessels coming to an anchorage, as vessels are not allowed to anchor within a certain distance on either side of the ferryboat route.

The Electric Mutual Benefit Association of the Thomson-Houston and Thomson Electric Welding companies held a meeting Friday evening, May 20, in Scientific Hall, when the officers submitted reports for the past year. The by-laws, as amended, add an auditor to the officers, and specify that when a member receives $50 in benefits he does not sacrifice his membership. Twenty-five cents will be the initiation in the future, instead of $1. President Randall read much interesting data bearing on the history of the association, showing that the total paid out for benefits the first year of existence of the order, ending May 1, 1887, was $253; 1888, $452; 1889, $830; 1890, $1,775; 1891, $2,000; and 1892, $1,895. The first year the membership was 168, to-day it is 600. The total paid out for running expenses up to May last was $143.72, while the total amount for benefit in that time was $5,075, and the total received $5,247. The past year 379 weeks of sickness were paid for in benefits of $5 per week. The treasurer's report for the past year shows that $1,895 were paid out for sick or accident benefits, about $35 for expenses; cash on hand May 1, $185, and the net receipts about $2,128. The meetings will be held semi-annually in the future, instead of annually. These officers were elected for the coming year: Prof. J. E. Randall, president; A. F. Batchelder, vice-president; Zenas Lord, 2d vice-president; Milton Babb, secretary; L. C. Norton, treasurer; J. R. Johnson, auditor; O. N. Ruple, C. G. Ball, W. H. Wood, A. W. P. White and W. H. Sisson, directors.

W. R. W.

WESTERN NOTES.

Branch Office of The Electrical World,
465 The Rookery, Chicago, May 23, 1892.

Mr. George Westinghouse, Jr., has secured the contract for the incandescent electric lighting at the World's Fair. He is to install 92,622 lamps on the alternating current system for $399,000, and is given until June 10 to file his bond and close the contract.

Mr. A. H. Bauer, chief electrician of the Pullman Company, states that the Pullman officials will afford the American Institute of Electrical Engineers every facility for inspecting the extensive works at Pullman during its visit to Chicago.

From Out of Town.—Among the visitors in Chicago this week were Mr. A. D. Adams, general sales agent of the Jenney Electric Motor Company, of Indianapolis, and Mr. W. B. Roberts, general manager of the Rockford Electric Manufacturing Company, of Rockford, Ill.

The Railway Equipment Company, Chicago, is moving into its handsome new warerooms, Nos. 163 and 164 Michigan avenue, on the ground floor of the Pullman Building, where it will have ample room to display its electric railway specialties to better advantage than in the quarters at No. 11 Adams street, which it is now vacating.

The Chicago Electrical Association.—On Tuesday evening, May 24, the members listened to an interesting paper prepared by Mr. Wait on the subject of "Sensitive Galvanometers"; and a thoughtful paper by Mr. Albert Scheible on "Some Forms of the Magnetic Bridge." The audience was unusually large although the night was a stormy one.

The Jenney Electric Motor Company, Indianapolis, Ind., has installed in the Brown-Ketchum Iron Works, in Indianapolis, a 50-h. p. Jenney generator and some 50 h. p. in Jenney motors, as it is the intention of the Brown-Ketchum Company to operate its factory throughout with electric power, doing away with heavy shafting, and drive the light shafting substituted by electric motors. F. de L.

Tacoma, Wash., May 20, 1892.

Cheny, Wash., is agitating putting in an electric light plant.

The Union Trunk Line, of Seattle, has built spurs on its Lake Washington and Beacon Hill lines to provide for its new 15-minute service to the lake.

Kent, Wash., will hold an election June 3 to decide on the advisability of bonding the city in the sum of $23,500 to purchase the local electric light and water works plants and extend the latter.

The Point Defiance, Tacoma and Edison Railway Company's extension, one mile in length, to the entrance of Point Defiance Park has been commenced by contractor J. M. Dougan.

The Columbia Land and Improvement Company has obtained important concessions of land, franchises, etc., from the city of Vancouver, Wash., where it purposes building an electric railway.

An electric railway is projected connecting Seattle and the town of Gilman. The distance by the proposed route from Maydenbauer Bay, Lake Washing to Lake Sammamish and up Squak Creek to Gilman, would be about 12 miles. The distance by the existing railroad line is 42 miles.

H. M. Byllesby, of St. Paul, president of the Northwest Thomson-Houston Electric Company, was in Tacoma recently on business connected with that company, and also to attend to the details of the proposed improvements of the Tacoma & Steilacoom Railway, of which he is also president.

The Sunset Telegraph and Telephone Company has awarded C. M. Johnson, of Tacoma, the contract to supply 30,000 cross-arms, which will be used in that company's extensions, which will eventually furnish telephone connections from British Columbia on the north to Mexico on the south.

The Northwest Thomson-Houston Company has removed the machinery which was intended to operate the Fidalgo City & Anacortes Electric Railroad, and stored the same in Seattle. Steam motors will probably be adopted by the Anacortes company in lieu of its unpaid-for electrical equipment.

The Port Townsend Construction and Railway Company, of Port Townsend, Wash., has elected Henry Landes, president; Chas. Eisenbeis, vice-president; Thos. Jackman, treasurer, and R. C. Hill, secretary. The company intends to equip the road with a complete electric plant as soon as business will warrant it.

The Tacoma & Steilacoom Railway will soon be merged with the Tacoma Railway and Motor Company's system, which will adopt the Thomson-Houston equipment as a standard. The plans for a terminal summer hotel at the Lemon ranch, costing $10,000, and for 1¾ additional mileage to reach the same will be carried out by the new combination.

The Everett Mining and Milling Company, of Everett, Wash., has awarded to W. T. McCaskey, representing the Edison General Electric Company, the contract for a complete electric plant for lighting and operating mills and mines. The generating plant of 150 h. p. capacity will be located on Toats Coulee Creek, about two miles below Loomiston. The plant is to be in operation by Aug. 1, and the contract price is $30,000. Fifty horse power will be utilized at the mine and 60 in the mills.

The Rainier Power & Railway Company, of Seattle, through President D. T. Denny, has awarded a contract for the construction and equipment of the Third Street Electric Railway line to Chas. H. Baker & Co. The Short system of car equipment has been adopted and will be used on six new vestibule cars, which will be constructed by the St. Louis Car Company. Two 80-h. p. National Railway generators and "Ideal" engines of 300 h. p. capacity will be supplied by the same contractors. The electric light plant of the company will be increased by the installation of National alternating apparatus having a capacity of 2,000 incandescent lamps, and Western Electric dynamos will supply 100 arc lights. G. R. De V.

ENGLISH NOTES.

(*From Our Own Correspondent.*)

London, May 21, 1892.

Derby.—The municipal authorities of Derby have voted £30,000 to carry out an electric lighting scheme.

Bristol.—The tender for the supply of dynamos for this station has been secured by Messrs. Siemens Brothers & Co.

Portsmouth.—The Town Council of Portsmouth, which is about to erect a municipal central station, proposes to carry out the major portion of the street lighting by means of 200 c. p. incandescents.

The City Lighting.—The City of London Electric Lighting Company has intimated that applications for electric supply have become so numerous, that it must for the next 12 months limit the number of connections, giving preference to premises already wired and customers who have signed guarantees.

Accident with an Electrical Coal Cutter.—A fatal accident took place in the north recently with an electric coal cutter. A young engineer, who had been sent down from London to conduct a demonstration, managed by some mishap to get mixed up with the coal cutter, the result being that both of his legs were badly mangled.

Electrical Nomenclature.—An attempt, fortunately frustrated, has been made by the Board of Trade to dub its unit of supply a "keline." Apart from the undesirability of allowing the initiative in this matter to be taken by others than scientific bodies of repute, the name was quite unnecessary The term kilowatt hour is perfectly definite, and to call it a "keline" is as absurd as to call a thousand cubic feet of gas a "murdoch."

London Electric Railway Schemes.—The Joint Committee of Lords and Commons continues to receive evidence with regard to the various electric railway schemes proposed for the metropolis. On Monday Mr. Preece gave a brief sketch of the rise and progress of electric traction in the United States. Mr. Alexander Siemens then gave evidence with regard to the tunnel proposed by the Great Northern Railway Company, which, as I have previously mentioned, that company proposes to make 16 instead of 12 feet in diameter, so that it may be large enough to take their ordinary rolling stock. I may mention here that the extra cost per mile of making these large tunnels is said to be no less than £100,000. The trains on the Great Northern Electric Railway will probably weigh 180 tons each, and Mr. Siemens estimates that it will be possible to run them from 8d. to 1s. per train mile. In reply to a question as to the ability of electromotors to drag such heavy loads, he said his firm was prepared, if necessary, to turn out locomotives with 600 h.p. motors. His firm had lately gone into the question of the cost of equipping the "Inner Circle" with a special electrical plant, and estimated that it would cost £150,000 to build 20 locomotives, to lay down the necessary mains, and to erect the necessary generating stations. The cost per train mile would be about 8d.

Troubles on Electric Supply Mains.—A couple of explosions in September last, and several more recent instances of damage to gas and water connections, due to defects on the St. James and Pall Mall company's system of mains, have afforded the gas journals a splendid opportunity of indulging in alarmist talk with at least a small show of reason. The facts are briefly as follows: Owing to accumulations of gas and water and some sparking from a faulty pilot wire, there were two explosions last autumn. In March this year a pastry cook in Piccadilly had a lead water-pipe eaten through twice, and several of his assistants received shocks from taps; and a few days after this the back of a gas meter resting against a damp wall in an adjacent house was found to have been pitted, apparently by electrolytic action. These occurrences soon brought Major Cardew, the Board of Trade Inspector, upon the scene, and he not unnaturally had his suspicions about a 2,500-volt main belonging to the London Electric Supply Corporation, which terminated in a "dead end" close by. This main was, however, found to be above suspicion, and the *fons et origo malorum* was ultimately discovered in the iron culvert of the St. James' Company, between which and the gas and water pipes there existed a difference of potential of six volts. On opening the culvert the negative conductor was found to be in contact with the iron through some fused lead-covered pilot wires lying at the bottom of the trough. On putting matters right at this point a near-by dead "earth," which had troubled the St. James' company since the autumn, and which they had been unable to localize, disappeared. Major Cardew has reported in favor of the immediate removal of all the pilot wires from the interior of the conduits, and is of opinion that "the steps to be taken by the Board of Trade to provide against the recurrence of similar faults and their consequences will require mature consideration."

The Supply of Electricity from Central Stations.—Some few months ago there was a decided tendency to despondency among electrical engineers in this country with regard to the future prospects of electric supply from central stations. It was pointed out that in the case of large establishments, such as hotels, big shops, mansion blocks, etc., which form the best customers of a central station, a private supply could be obtained by means of a gas engine dynamos and accumulators at something like half the price at present charged in the metropolis. Another cause of despondency was the absence of any demand for motors, large or small, and the fact that even if the demand were to arise it would be an unmitigated blessing, since the call for motive power and for light would in this country probably overlap. The accounts of the companies supplying the metropolis for the past year are now all to hand and may be considered on the whole satisfactory and encouraging. One company only, the St. James & Pall Mall Company, perhaps the most favorably situated in the world, has succeeded in paying a really attractive dividend (8½ per cent.). On the other hand, small dividends have been paid by two companies, viz.: the Kensington & Knightsbridge and the Metropolitan Electric Supply Companies. The Westminster company, while not actually paying a dividend, will no doubt do so next year. On the other hand, we have of course that colossal financial failure, the London Electric Supply Corporation, the shareholders of which, together with those of the House to House and Chelsea companies, have as yet received no return for their money. On the whole the electric lighting companies have done better in the provinces, if we merely look at the amount of dividends paid and do not look too closely as to how the figures have been arrived at; thus Hastings is able to pay 7½ per cent.; Newcastle, 4 per cent.; Bath, 4 per cent.; Keswick, 3 per cent.; Liverpool, 4½ per cent. Considering the recent birth of the central station industry and the fierce competition with gas, these figures really give no cause for despondency, especially in view of the data given in a paper read before the Society of Arts by Mr. Shoolbred, on the Bradford Corporation Electricity Supply. The Bradford corporation took over their station from Messrs. Siemens Brothers, the contractors, on Jan. 1, 1890, the station being on the plain two wire system with accumulators. At first there was a small loss, but now there is a handsome profit. The nature of the supply at Bradford is of a particularly trying kind, being almost entirely shops, with a few large hotels and warehouses. Within the past few months, however, there has been a decided demand for motors, and it is highly probable that a portion of the tramway system of the town will shortly be run off the electric lighting mains. Since the commencement of the supply at Bradford, the cost of production per unit has fallen from 5¼d. to 2½d., and the average half-yearly output has increased from 39,000 to 150,000 units. While the output and receipts have thus quadrupled, the coal consumption and wages have only grown by about 50 per cent. The fuel used is a mixture of "nuts" (8 to 10 shillings per ton), "dust" (5 shillings per ton) and coke. Mr. Shoolbred is of opinion that a great saving has been effected by the use of feed-water heaters and fuel economizers. When the water was fed direct from the mains to the boilers it entered them at a temperature of 55 degrees Fahrenheit; on leaving the feed water heater it is now 180 degrees, and after leaving the fuel economizers 200 degrees.

Inquiries from Correspondents.

Queries to be inserted in this column must be of general electrical interest, and must be accompanied by the real name and address, not necessarily for publication, but as a guarantee of good faith. No notice will be taken of questions which involve nothing more than can be found in elementary treatises on the subject. All correspondence should be as brief as is consistent with clearness. Readers are invited to send discussions and answers to these questions, which will be inserted in the column below.

[116.] What are the ingredients, method of solidifying, etc., for that quality of carbon used in telephones or for similar purposes?
E. A. G.

[117.] Would you regard it as practicable to put aluminium springs in a storage battery plate to prevent the active material from falling out, due to expansion? Would it also decrease the resistance between the active material and the plate? C. A.

[118.] I have four bells and four push buttons, one on each of four different floors. How can I arrange it so that any bell can be rung from any floor?

[119.] What are the alloys used for storage battery plates?
D. B. S.

Answers to Correspondents.

Readers are invited to send discussions regarding, or answers to the queries published in the column above, or with regard to any other live questions on electrical subjects. In answering questions please refer to them by their serial number. Correspondence must be accompanied by the real name and address, not necessarily for publication, but as a guarantee of good faith. Names of correspondents will be printed in full unless otherwise requested. All correspondence should be as brief as is consistent with clearness. THE ELECTRICAL WORLD *assumes no responsibility for the opinions expressed by correspondents.*

[58.] It is hardly possible to say just how a dry battery compares in strength with a wet one, because it depends largely upon the particular batteries in question. In general, the available potential of the dry battery is somewhat less and it should only be employed for intermittent service. A. B.

[74.] Compressed soft iron filings would doubtless do very well for the core of an ordinary Ruhmkorff coil, but probably would not give as efficient a result as soft iron wire on account of their greater magnetic resistance. C. D.

[75.] See "Induction coils—How Made and How Used," by Dyer.

[79.] See Thompson's "Electromagnet." A. B.

[83.] Incandescent lamps cannot be run at any great distance from the transformer, because either the resistance of the secondary would become so great that the loss from heating would be altogether too large, or if this was avoided by increasing the size of the conductor the cost would become practically prohibitive.
H. W.

[87.] The well-known Gassner dry cell consists of a zinc containing vessel, usually covered with paper or enclosed in a paper box, and a negative element of carbon which occupies about one-half of the space in the cell. The paste which is filled in between has the following composition, by weight: Oxide of zinc, 1 part; sal-ammoniac, 1 part; plaster, 3 parts; chloride of zinc, 1 part; water, 2 parts. For the composition of other dry cells see Carhart's "Primary Batteries." H. W.

News of the Week.

THE TELEPHONE.

The Ontario Telephone Company, of Peterboro, Ont., has been absorbed, it is stated, by the Bell Telephone Company.

The Bell Telephone Company's instrument output for the month ending May 20 and for the fiscal year to the same date is reported as follows:

Month ended May 20.	1892.	1891.	Inc.
Gross	10,724	7,346	3,378
Returned	4,592	3,255	1,337
Net	6,132	4,091	2,041
Since Dec. 20.	1891-92.	1890-91.	Inc.
Gross	41,212	29,713	11,499
Returned	23,196	16,094	7,102
Net	18,016	13,619	4,397

THE ELECTRIC LIGHT.

Camden, O., has decided to put in an electric light plant.

Cameron, Tex.—An electric light plant will be erected at this place.

Haddonfield, Pa.—$3,500 has been appropriated for electric lighting.

Royersford, Pa., is contemplating lighting the village by electricity.

Spring City, Pa.—Council and citizens are agitating the question of electric light for the village.

North Tonawanda, N. Y.—At a meeting of the Common Council it was decided to extend the electric lights to Martinsville.

Yoakum, Tex.—A contract has been let to the San Antonio Improvement Company to erect a $5,000 electric light plant for this place.

Laconia, N. H.—The Laconia Electric Light Company contemplates increasing the capacity of its plant by the addition of a 50-light dynamo.

North Plainfield, N. J.—The plant of the Edison Electric Light Company has been sold to J. H. Cooley and T. S. Davis, who contemplate increasing its capacity.

The Pawtucket Gas and Electric Light Company, of Pawtucket, R. I., has extended and increased the capacity of its plant, and will hereafter furnish power service.

Syracuse, N. Y.—The Thomson-Houston company has secured control of the Syracuse Electric Light and Power Company. It is said that $150,000 will be spent to improve the plant.

Silver Creek, N. Y.—At a meeting of the taxpayers it was decided by vote to light the city by electricity. A plant costing $20,000 will be put in operation by residents of this village. The company will be known as the Silver Creek Electric Light Company.

The Edison Electric Light and Power Company, of Trenton, N. J., recently incorporated, note of which was made in THE ELECTRICAL WORLD of May 28, has let the contract for its arc lighting apparatus to the Fort Wayne Electric Company and to the Edison General Electric Company for its incandescent apparatus. Work will begin at once constructing the plant. It is stated that the plans contemplate a model electric lighting station.

THE ELECTRIC RAILWAY.

Peoria, Ill.—The Fort Clark Street Railway lines are now operated by electricity. Extensions are contemplated.

Pittsburg, Pa.—The West End Street Railway Company has been granted permission to change its motive power to electricity.

The St. Joseph & Benton Harbor Street Railway Company, of St. Joseph, Mich., is changing its system from horse power to electricity.

Manchester, N. H.—The directors of the Manchester Street Railway Company have decided, it is stated, to build an electric railway to Lake Massabesic.

Baltimore, Md.—The work of equipping the Central Railway Company's lines is being rapidly pushed, and it is expected the road will be operated by electricity by the last of July.

Chillicothe, O.—The street railway system, which is five miles long, will be extended and equipped electrically by the new company which recently purchased the franchise of the company for $50,000.

The Worcester and Millbury Electric Railway Company, of Worcester, Mass., at a recent meeting of its stockholders awarded the contracts for its power station and electrical equipment. It is expected the road will be ready for operation by August 1.

Oskaloosa, Ia.—An electric street car line, to run from this city to Carbonado and Beacon, is to be constructed at an expense of about $100,000. The line will be eight miles long. The parties who are interested in the line are C. H. Chandler and C. A. Ross, of Kansas City, and Frank French, of London, England, and they have attested their good will by depositing a bonus of $1,000.

Electricity vs. Steam.—The experiment of using electricity in place of steam on a standard gauge railroad is to be made at Ellwood, Pa., on the Beaver & Ellwood Railroad from Ellwood to Ellwood Junction, a distance of three miles from Pittsburgh, where connection is made with the Pennsylvania lines. The electric cars will be run over the same road and rails used by the present steam line.

The Consolidated Street Railway Company of Grand Rapids, Mich., gave the first trial on Sunday, May 22, to one of the "Gearless" motors ordered from the Short Electric Railway Company some months ago. A party of Grand Rapids and Chicago gentlemen rode over the road with General Manager Chapman and all expressed great satisfaction with the operation of the car. A grade of 9½ per cent. was ascended at a speed of nine miles per hour, the car being stopped and started in the middle of the grade with ease. These motors are of the slow speed type built for climbing hills but will make 25 miles per hour on a level.

LEGAL NOTES.

Suit for Commission.—Edward B. Hess has brought suit against the Thomson-Houston Electric Company for a commission of five per cent. upon the purchase price of the electrical equipment of the Harlem Bridge, Morrisania & Fordham Railroad. Mr. Hess claims that he obtained the contract for the Thomson-Houston Company, and it agreed to pay him the above commission. Judge Lawrence of the Supreme Court rendered a decision directing President C. A. Coffin to disclose the amount that his company was to receive for the equipment.

Baltimore, Md.—On May 23, Judge Morris, of the U. S. Circuit Court, heard the bill in equity brought against the Baltimore & Ohio Telegraph Company and the Baltimore & Ohio Railroad Company by the Interstate Telegraph Company. The Interstate Telegraph Company is incorporated under the laws of Michigan, and on April 19, 1890, it recovered a judgment against the Baltimore & Ohio Telegraph Company for $25,000 for the breach of two contracts, but the execution was returned unsatisfied, as the telegraph company claimed it had no property liable to execution. The Baltimore & Ohio Railroad Company incorporated the Baltimore & Ohio Telegraph Company and furnished the capital for it, and the Interstate company now seeks to include it in the case, and therefore asks that a receiver be appointed for the telegraph company and that the railroad company be compelled to pay over to this receiver a sum sufficient to cover all liabilities. Judge Morris held the case under advisement.

PERSONALS.

Mr. T. W. Ness, of Montreal, Canada, was in New York last week.

The Shultz Family Reunion.—On May 20, 1892, the Shultz family held a reunion at Shipman, Ill. It was the birthday of the mother of the family, Mrs. Nancy Shultz, who is still living at the age of ninety. One of the sons is John A. J. Shultz, president of the Shultz Belting Company, of St. Louis, Mo. The living descendants of Mrs. Shultz comprise five generations, and reach the number of two hundred and twenty-three.

Mr. Wm. J. Phillips, ex-president of the American District Telegraph Company, and at one time superintendent of the Philadelphia electrical department, died on Monday, May 23. Mr. Phillips was born in New York in 1825, and was a lineal descendant of Sir Thomas Phillips, of Milford Haven, Wales. At the age of 20 he became the associate of Prof. Royal E. House, who was perfecting the House telegraph instrument. Two years later Mr. Phillips was general manager of the first office in Philadelphia which used that instrument. In 1854 he secured a contract with the city for the erection of the municipal telegraph, completed in 1856, in which year he was elected superintendent of the electrical department by City Councils, which position he held about 30 years. Mr. Phillips introduced the fire alarm telegraph in Baltimore, Washington, Cincinnati, Chicago and San Francisco. He was telegraph director and chief of the Bureau of Telegraphy of the Centennial Exhibition, and was connected with the Franklin Institute and a number of business companies. He was a frequent and successful patentee in the line of electrical apparatus, many of his improvements being in general use.

MISCELLANEOUS NOTES.

Bridges to be Operated by Electric Motors.—The Board of Public Works of Milwaukee, Wis., has recently ordered three bridge motors from the Thomson Houston Electric Company for the purpose of operating three bridges in the city. The contract amounts to about $4,500.

Wires to go Underground.—At a recent conference between the Mayor of Pittsburgh, Pa., and representatives of the telegraph, telephone and other corporations now using overhead wires, an agreement was reached that the work of burying the wires should be begun by August 1st next and completed within four years, not less than 25 per cent. of the wires to be put down each year.

Electricity in Mining.—Electricity is to be introduced in the Cashier Champion mine, of Summit county, Colo. The mine is at the head of the Snake River above Montezuma. An electric railway will be constructed, electric mining apparatus installed, and it is expected the plant will be ready for operation before winter.

The Denver Electrical Association, recently incorporated by W. D. Tyler, C. F. Hart, W. J. Barker, C. C. Heasley and Frank Sturges, has for its object to "advance the science of electricity and to educate its members in the management of electrical plants." The organization is of a scientific and educational character.

The American Street Railroad Association, through its special Columbian Exposition Committee, has issued a letter urging all those who desire to exhibit street railway apparatus to make application at once. The association has secured 50,000 square feet of space, and allotments will be made in order of applications received. No charge will be made for space, and a limited amount of power will be supplied without cost. Exhibits will be received as early as Nov. 1, 1892, and not later than April 10, 1893. Complete rules and information concerning exhibits can be obtained on application to Mr. Willard A. Smith, Chief of the Department of Transportation of the World's Columbian Exposition.

Industrial and Trade Notes.

H. E. and C. Baxter, of Brooklyn, N. Y., manufacturers of electrical supplies, have removed their office and factory to Bedford, Canton and Division streets.

At Koster & Bial's Theatre during the past week four Ward ornamental lamps have attracted a good deal of attention and embody the best designs in that line of work.

The Shultz Belting Company.—A. B. Laurence, 225 Pearl street, New York, has received orders for three 8-inch dynamo belts for the Citizens' Electric Lighting Company, of Far Rockaway, N.Y.

George Cutter, of Chicago, in reply to a letter sent out by another firm reflecting upon the improved Schaefer lamp, says that the Germania Electric Company is now in better shape than ever to manufacture the genuine article.

The Electrical Supply Company, of Chicago, has issued a pocket edition of its catalogue No. 237 of electric light and power supplies. It is a complete photographic reproduction, and its small size will make it very convenient for business men.

The Northern Car Company has just finished the first of the new car bodies for the Duluth Street Railway Company. The car is equipped with 20-h. p. Short gearless motors, and will be placed on the line at the head of the incline back of the city of Duluth, the maximum grade being 4½ per cent.

The Nassau Electrical Company, 112 White street, N. Y. has just issued a small folder describing a number of new specialties, among which is the Nassau Electrical Gas Lighter, which is claimed to be certain of action under all conditions, and an electro-faradic hair brush which has many excellent qualities.

The Williams Engine Works, of Baltimore, Md., reports that so many orders are coming in that it is necessary to do night work, and a contract is being made with another large shop to take part of the work. Yacht engines, standard engines and very high speed engines for direct coupling are being built.

The Electric Appliance Company reports having received a single order for 34 miles No. 6 Canvas Jacket line wire from one of the largest lighting companies in the West. The company reports a very large demand for Canvas Jacket wire generally throughout the country and the demand for flexible conduit has been so heavy that it are unable to fill orders and the factory is now several hundred thousand feet behind.

H. K. Lee, mechanical engineer of Hartford, Conn., has purchased the machine works of Reid & Hill, of Hartford, and hereafter will make a specialty of mill repairs and the rebuilding of steam engines. Mr. Lee is sales agent for the Buckeye Engine Company, and he will also manufacture dynamos for light, power and other electrical work, and will make estimates upon electric lighting and complete steam plants upon application.

The Vulcanized Fibre Company, 14 Dey street, New York, has supplied a long felt want by bringing out its "insulating saddle staple." They are so made that no driving tool is required, and they will drive equally well into hard or soft wood. They have the advantages of not injuring the insulation, but rather reinforcing it, it is stated, and are cheaper and more expeditiously applied than cleats. The National Code of Wiring Rules recommends the use of staples with insulating strips or saddles.

The Berlin Iron Bridge Company, of East Berlin, Conn., is to design and construct the new power station for the Newport News Shipbuilding and Dry Dock Company, at Newport News, Va. The building is to be absolutely fireproof, as it is to contain the steam, compressed air, hot air and electric plants for the entire shipyards. The walls will be of brick, the floors of iron and concrete and the roof will consist of an iron frame covered with the Berlin Iron Bridge Company's patent anti-condensation corrugated iron covering.

The Ball & Wood Company, of No. 15 Cortlandt street, New York, has just shipped the eighth 150 h. p. engine within as many months to the Edison Electric Illuminating Company, of Paterson, N. J. In addition to this average of one engine per month, they have also furnished the same company one of their improved 300 h. p. compounds. Visitors to the Ball & Wood shops at Elizabeth will now see over 30 engines under construction, embracing types of their improved simple, tandem, compound and cross compound engines all on contract and in preparation for early delivery.

Powerful Turbines for Niagara.—The immense new pulp and paper plant of the Cliff Paper Company at Niagara Falls are to be supplied with late new designs of the horizontal shaft double discharge James Leffel wheels, built by James Leffel & Co., Springfield, O. The contract for this work was signed by the Cliff Paper Company and James Leffel & Co. on May 13, after the Cliff Company had made a full and careful investigation of the subject. Each of these turbines is to be eleven hundred (1,100) horse power capacity, and built essentially upon the plan of the style No. 23, illustrated in the pamphlet of James Leffel & Co. These wheels will connect directly to the pulp grinder shafts at each end of the wheel shafts, without belts or gearing. This water wheel company has celebrated its thirtieth year of continuous business in this line of work. It has added many improvements to the James Leffel wheel in the past two years and has designed a large number of new styles, incorporating in them the best ideas of large experience. The manufacturing plant of this company has also been recently greatly extended and various pieces of new improved and heavy machinery added, all adapted to the heavy water-wheel work it is now manufacturing. It shipped some time since one James Leffel wheel and casing weighing 45 tons; also filled orders for 19 large wheels for one pulp and paper company.

Business Notices.

Battery Cut-Out, Cheap.—Sensitive, reliable, never requires attention. Gas lighting much improved by its use. Electric Supply Company, of 105 South Warren street, Syracuse, N. Y.

Molds for casting battery zincs are made of iron and steel. We have just completed sets for the "D'Infreville Patent Wasteless Zinc," costing over $40 each. H. Brooke, 44 Barclay street.

Type 15 L of the Consolidated Electric Storage Company yields four hundred ampère-hours at a continuous discharge of 30 ampères. It is almost identical in size and weight with the 15 L. of the Accumulator Company, and will fit the 15 L. jar of that company.

Thirty-five-light, 2,000-c. p. American arc dynamo in good condition, for sale at a bargain; also 750-light Westinghouse alternator, with station appliances. Address E. T. Pardee, 10 Butler Building, Syracuse, N. Y.

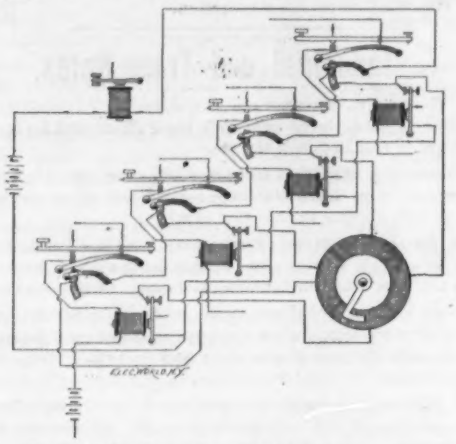
Burlington Route—New Service.—A through Pullman sleeping car, Chicago to San Francisco, is a feature of the Burlington's new service. This car leaves Chicago daily on the fast train at 1:00 P. M., and runs via Denver, Colorado Springs, Leadville, Glenwood Springs, Salt Lake City and Ogden, arriving in San Francisco at 11:45 A. M., less than four days *en route*.

OUR ILLUSTRATED RECORD OF ELECTRICAL PATENTS.

[In Charge of W. A. Rosenbaum, 177 Times Bldg., N. Y.]

U. S. PATENTS ISSUED MAY 24, 1892.

475,289. Electric Arc Lamp; Lucien Brianne, Paris, France. Application filed July 28, 1891. Contrary to almost every existing apparatus, the weight mechanically separates the carbons and the current brings them together, whereby an effective working is insured.



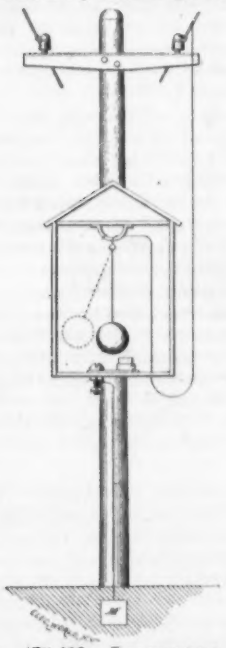
No. 475,468.—ELECTRICAL TRANSMITTING SYSTEM.

475,300. Extension Transmitter for Telephones; Victor A. Cook, New York. Application filed Jan. 8, 1892. An extension mouthpiece for telephone transmitters, consisting of a tube, a disc of smaller diameter supported centrally within the tube, a spring plate for securing the tube in front of the transmitter, and a conical flange supported by the clip and adapted to enter the aperture in the casing over the transmitter.

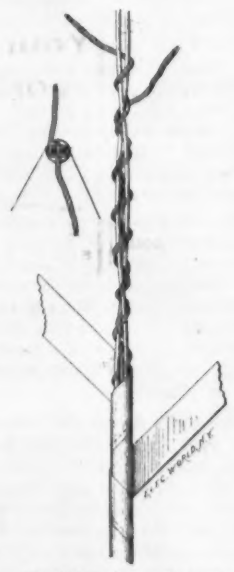
475,334. Electric Signaling Apparatus; Wm. C. Moore, Kansas City, Mo. Application filed June 19, 1891. An individual call apparatus having a movable circuit-closing device operatively connected with the armatures of two electromagnets, adapted each to give to it a forward step-by-step movement, a mechanical retarding device for preventing one of the magnets from acting for simple closures of the signaling circuit, and a signal receiver in circuit with the circuit closing device, one of the propelling electromagnets acting to advance the circuit closer for simple current impulses and the other only for abnormal breaks of the circuit.

475,335. Manufacture of Electrodes for Secondary Batteries; Jas. F. McLaughlin, Philadelphia, Pa. Application filed Jan. 31, 1890. The improvement in the art of making secondary battery electrodes, which consists in packing against a suitable conductor support in a non-conducting mold dry powdered active material and then solidifying and joining said material to its support by electrolytic action.

475,340. Automatic Electric Heat-Alarm; Fred Sumner Palmer, Boston, Mass. Application filed Jan. 9, 1892. An automatic electric heat-alarm consisting of the combination of a hollow metallic reservoir, a quantity of mercury within said reservoir, a plug constructed of material which is a non-condenser of electricity partially filling said reservoir and having a small downwardly extending tubular bore, a conductor-wire or spindle



No. 475,482.—LIGHTNING ARRESTER.



No. 475,648.—ANTI-INDUCTIVE CONDUCTOR.

supported within and surrounded by said non-conducting plug and extending to such point as that it may be reached by said mercury when expanded and risen in said tube, a second conductor wire or spindle supported within said plug and in contact with said mercury before said mercury is expanded, the whole in combination with an electric battery having its poles connected with said spindles, respectively, and a bell or other alarm or indicator connected with and operated by said electric battery.

475,345. Incandescent Lamp Socket; Fred C. Rockwell, Hartford, Conn. Application filed Feb. 24, 1892. As a new article of manufacture, a socket for an incandescent electric lamp, consisting of a shell having a recess for the reception of a lamp end with perforation through the shell, and binding contacts on the interior adjacent to the perforations adapted to make contact between the circuit wires and the terminals of the lamp.

475,360. Amalgamator; Jas. M. Thompson, San Francisco, Cal. Application filed Jan. 12, 1891. The combination of an angular vessel having a vertical and an inclined chamber communicating at the bottom, an endless belt in the inclined chamber, a scraper in juxtaposition to the belt pulleys upon which the belt runs, a vertical sleeve in the vertical chamber carrying a disc at the bottom provided with downwardly projecting agitators, and above said disc a series of radial paddles, a shaft within the sleeve, having a rotary disc at the bottom provided with upwardly projecting agitators, a gear on both sleeve and shaft, means for driving the sleeve, shaft and endless belt, a battery, wire connections with the battery to the interior of the vessel above and below the agitators, and a mercury bath in the vessel.

475,378. Station Indicator; Reuben B. Ayres, New York. Application filed Dec. 3, 1891. In an electrical street or station indicator, the combination of a duplicate set of electromagnets, an intermediate armature, a tongue movably connected to said armature and working back and forth longitudinally, and a suitable battery and wire connections for energizing the magnets.

475,394. Incandescent Electric Lamp; Henry Green, Hartford, Conn. Application filed Aug. 22, 1891. In an incandescent lamp made entirely of glass, a pair of circuit wires or conductors attached in the usual manner to the platinum wires and trained up the sides of the hollow recess in the centre of the neck of the lamp and fastened thereto by a fusion of a small portion of glass.

475,410. Electric Mechanism for Reciprocating Motion; Henry S. McKay, Boston, Mass. Application filed Aug. 20, 1891. In combination with an electric circuit, two or more electro-magnetic devices, an armature adapted to be reciprocated by the magnetic devices, and a non-circuit-breaking commutator adapted to be actuated directly by the reciprocating armature to alternately change the course of the current to alternately energize the magnets, and thereby cause the armature to reciprocate without breaking the circuit and without said armature.

475,411. Electric Meter; Alexander C. McKenna, Allegheny, Pa. Application filed July 14, 1891. In an electric meter, an electrolytic cell containing a mercurial salt and having suitable electrodes and a receptacle for catching the deposited mercury.

475,441. Telegraphic Relay; Charles Cuttriss, New York. Application filed Dec. 1, 1891. A sensitive rheostat or device for varying the resistance of an electric circuit, composed of an attenuated resilient resistance conducting strip included in the circuit to be varied and wound or bent in symmetrical convolutions or spires, in combination with a stationary support and a body movable in response to current or other waves, the ends of said conducting strip being respectively connected to the stationary support and movable body.

475,442. Sealing Device; Charles Cuttriss, New York. Application filed March 5, 1892. A sealing device consisting of a tube or holder for containing a stick or piece of sealingwax or like material, a refractory wire or grating at the end of said tube, and means for directing an electric current through the wire.

475,467. Trolley for Electric Railways; John W. Newhouse, Indianapolis, Ind. Application filed Nov. 14, 1891. The combination, in a trolley for electric railways, of two side pieces having recesses on the surfaces which face each other, adapted to receive and hold the ends of the shaft of the wheel, the wheel and shaft.

475,468. Electrical Transmitting System; Frederick E. Now, Cleveland, O. Application filed Dec. 4, 1891. In an electrical transmitting system, separate lines, sending and receiving devices in circuit with each of said lines, a distinctly separate and single local translating device, means in circuit with the receiving devices adapted to automatically connect said local mechanism with the several receivers in periodic succession, and other means auxiliary to said sending devices adapted to automatically connect the local device with the receiving mechanism corresponding to the sending device actuated.

475,482. Lightning Arrester; James E. Browne and Fred. H. Tidnam, Elizabeth, N. J. Application filed July 10, 1889. This invention relates to improvements in lightning arresters, in which an air space is left between the line and ground connections of the lightning arrester.

475,491. Electric Locomotive; Thomas A. Edison, Llewellyn Park, N. J. Application filed June 3, 1880. An electric railway having in combination the following elements: A stationary dynamo-electric generator, a wheeled vehicle traveling upon rails, an electro-dynamic motor mounted upon such wheeled vehicle, having its field and armature coils in separate circuits, electrical connections between the motor upon the vehicle and said generator, and controlling devices mounted upon said wheeled vehicle for starting, stopping and reversing its movement, whereby the movement of the wheeled vehicle can be completely controlled by a person riding thereon.

475,492. Electric Locomotive; Thomas A. Edison, Llewellyn Park, N. J. Application filed June 3, 1880. The combination of a wheeled vehicle, an electric motor located thereon mechanically connected with a wheel or axle thereof, a source of electricity, a circuit including said source of electricity and motor, a track composed of rails, upon which said vehicle travels, and a supplemental grooved traction wheel upon said vehicle rotated by the same source of power as the motor, adapted to grasp or grip the track.

475,493. Electric Locomotive; Thomas A. Edison, Llewellyn Park, N. J. Application filed June 3, 1880. In an electric railway having a suitable source of current and supply conductors, the combination with a car of an electric motor mounted thereon, and two derived or multiple-arc circuits, one including the rotating armature of the motor, the other including the coils of the field magnets.

475,494. Electric Railway; Thomas A. Edison, Llewellyn Park, N. J. Application filed June 3, 1880. The combination in an electric railway system, of a stationary source of electricity, a moving vehicle, an electric motor on the vehicle, mechanical connections between the rotating part of the motor and a wheel or axle of the vehicle, a main line of conductors extending from the source of electricity to the vehicle, having a section thereof isolated from adjacent sections in the same line, and traveling contacts connecting the circuit on the vehicle with the main line or circuit or a section thereof, whereby the variation due to the described arrangement of the main line is automatically imparted to the motor to produce a corresponding variation in the movement of the vehicle.

475,504. Switch for Overhead Wires; Alphonso O. Hoyt and Paul W. Leffler, Minneapolis, Minn. Application filed Sept. 10, 1891. A trolley guide for use on crossing and switch pans, consisting of an arm having lateral flanges curving upward substantially continuous from the edge of the pan and having means at its outer end for holding the conductor at a point below the level of the outermost tip of the flanges equal to or greater than the depth of the trolley wheel flanges.

475,514. Electric-Car Lighting System; James F. McElroy, Albany, N. Y. Application filed Dec. 19, 1891. The object af this invention is to provide a practical system for lighting cars by generating the current required for the maintenance of lights by means of a dynamo operated by the motion of the train itself and employing in connection therewith a storage battery of sufficient capacity to maintain the light during stoppages.

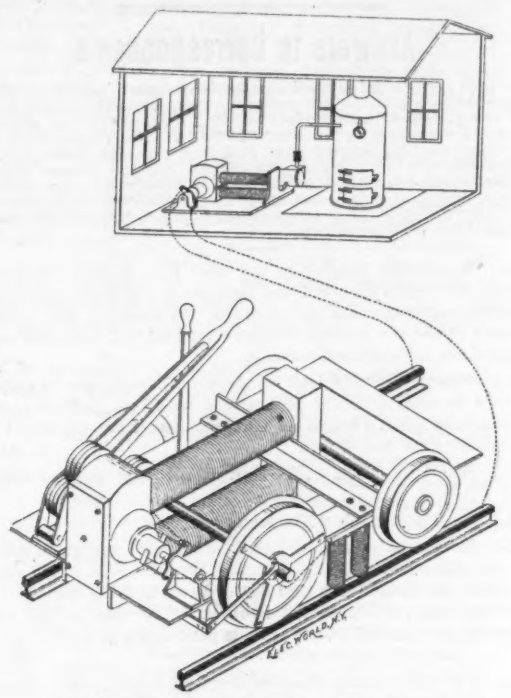
475,528. Rheostat; Charles Willms, Baltimore, Md. Application filed Jan. 14, 1892. An adhesive resistance material for rheostats, containing adhesive material, finely divided conductive material, and metal filings or similar particles of high conductivity.

475,529. Rheostat; Charles Willms, Baltimore, Md. Application filed Jan. 14, 1892. In a rheostat, the combination, with a supporting block provided with grooves, of a conducting plate with which one or more series of conductors arranged in said grooves and extending through the block, a movable contact-piece with which the other conductor of the circuit connects and which is adapted to form contact with any one of each series of conductors and resistance material applied to the conductors within the grooves and forming a path or paths for the current between the conducting plate and successive conductors.

475,538. System of Electric Lighting; Milo J. Cowgill, Omaha, Neb. Application filed Oct. 22, 1891. In an apparatus for electric lighting, the combination with a high voltage dynamo, of a commutator sleeve of non-conducting material mounted upon the armature shaft, said sleeve being provided with a series of inlaid peripheral segments of copper, a common return collar all in electric connection with the armature coils, a series of branches mounted in the path of the segments and return collar, there being two brushes for each segment, and a multiple system of circuits extending from said brushes and common return collar, so that as the armature revolves the current passes over the circuits intermittently and but during the fractional part of the time of each revolution of the armature, thus making it possible to use a low voltage lamp on a high voltage circuit.

475,544. Electric-Arc Lamp; Robert S. Dobbie, Brooklyn, N. Y. Application filed June 11, 1891. The combination with the electrodes of an arc lamp, of an inclosing device around the arc for conserving the heat and intensifying the light thereof, the body having an escape passage and a draft inducing device for diverting gases through said passage from the space in front of the arc.

475,555. Incandescent Lamp Socket; Cromwell A. B. Halvorson, Saugus, Mass. Application filed Aug. 5, 1891. In an electric circuit, the combination of a fixed contact, a spring affixed to a support which is fixed relatively to said contact, and has its free end formed as a contact, which is normally separated from the contact by the stress of the spring, a block or cam of insulating material journaled in fixed bearings and bearings on said spring, the block having pinion teeth, a slide having a rack arranged to engage said teeth, and means for limiting the motion of the slide.



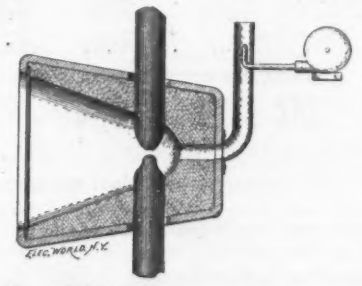
No. 475,494.—ELECTRIC RAILWAY.

475,600. Cable Hanger; John J. Nate, Chicago, Ill. Application filed March 24, 1892. In a cable hanger, the combination, with a hook, of a metallic base to which said hook is attached, the base being provided with four openings adapted to receive a wire or wires, and the wire or wires adapted to be fastened to the base and to surround and support the cable at two points.

475,645. Lightning Arrester; Addison G. Waterhouse Hartford, Conn. Application filed Dec. 17, 1891. A lightning arrester composed of three stationary flash-plates, two of which are connected to the main circuit of a dynamo-electric machine at different points on the line, and the third being electrically connected to the earth.

475,648. Anti-Inductive Conductor; Bror Hemming Wesslau, Charlottenburg, Germany. Application filed Jan 21, 1892. An anti-inductive conductor having an open network of threads of insulating material wound or plaited thereon, with air spaces between the threads, and an outer envelope of insulating material wound around the exterior of the threads and inclosing the threads and air spaces.

475,651. Device for Heating Metal Rods; Alfred D. Williamson, London, England. Application filed Oct. 21, 1891. In an apparatus for electrically heating a metal rod, bar or wire, the combination of a stationary and a movable frame, interiorly coned conductors carried by the stationary and movable frames, a carbon tube provided with exteriorly coned ends to engage the interiorly coned sleeves carried by the stationary and movable frames, and springs connected with the stationary and movable frames to retain the coned conductors and carbon tube in close contact.



No. 475,544.—ELECTRIC ARC LAMP.

475,667. Hoop-Welding Apparatus; Charles L. Coffin, Detroit, Mich. Application filed April 25, 1891. In a machine for electrically welding, working, or forging hoops, the combination of pivoted clamps for holding the ends of the hoop, a toggle joint for moving said clamps, a stationary bridging conductor and a movable frame carrying two conductors insulated from each other and respectively connected with the opposite poles of a generator of electricity.

475,668. Commutator-Brush; Charles L. Coffin, Detroit, Mich. Application filed Sept. 5, 1891. A commutator brush consisting of a strip of perforated sheet metal.

475,702. Electric-Motor Car; William H. Patton, Chicago, Ill. Application filed Sept. 7, 1891. A motor system for car propulsion, comprising a gas engine or analogous primary source of power, a dynamo operated by the engine, an electric motor supplied by the dynamo, and a storage battery supplied from the dynamo and connected therewith in circuit, so that it can be employed as a source of supply for temporarily running the dynamo as a motor, operating to start up the engine.

475,703. Electrically Heated Sand Box; Lewis Edwin Pease, Cambridge, Mass. Application filed Nov. 16, 1891. An electric sand box comprising a box having a cover, a sand pipe provided with a valve mechanism for operating said valve, braces projecting from the top of the box, a hood supported on said braces, and heating pipe fitting into said hood.

475,727. Electric-Arc Lamp; Jas. E. Gaston, Sparta, Ill. Application filed Sept. 4, 1891. In an electric-arc lamp, a carbon holder having a tubular socket fitted near one end with a housing, having a screw threaded perforation, and a broad thin shank, located at the opposite end of said socket, so as to be held at right angles thereto and in alignment with said housing, whereby both the housing and the shank are adapted to slide within the slot of a slotted carbon steadying device.

Copies of the specifications and drawings complete of any patent mentioned in this record—or of any other patent issued since 1836—can be had for 25 cents. Give date and number of patent desired and address The W. J. Johnston Co., Ltd., Times Building, N. Y.